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Economy in Wood Preservation

ATTENTION was called in this journal on Sept. 12 to the shortage in creosote due to the war. Suggestions were there made as to expedients to tide over the situation. The Engineering Record is fortunate now in being able to present, on page 346, a thorough analysis of the situation, with a greater number of suggested remedies. The paper comes from Mr. Teesdale of the Forest Products Service and warrants the careful reading of all those using timber extensively or concerned with its preservation.

Caution in Paving Work

IT should be well known that the best results cannot be secured when sheet asphalt, asphaltic concrete or asphaltic macadam construction is attempted in wet weather; and yet an authority on road building who probably sees as much construction as any one in the country recently stated that this fact does not seem to be appreciated or at least regarded by contractors. He might have mentioned at the same time that good work cannot be done with dirty stone any more than it can with damp or cold stone. The season is approaching when the temptation to put through bituminous work in a hurry despite wet weather will be very strong; but contractors will serve their own best interests and inspectors and other authorities will be performing only an elementary duty if they insist that bituminous paving work shall not be attempted under conditions that make it impossible to keep dry the stone that is being used and the surfaces on which it is laid. Asphalt pavements can, of course, be patched on a small scale, but large yardages of any form cannot be successfully laid in wet weather.

Razing a Concrete Stack

ALTHOUGH the reinforced-concrete stack at the Torresdale filtration plant in Philadelphia appeared to be unsafe and was known to have been built under unfavorable weather conditions, its demolition shows that it was, nevertheless, in a satisfactory condition and would have been serviceable for years to come. A detailed account of the conditions found appears on page 348. The position taken by the officials of the Bureau of Water, however, is easily understood, and the condemnation of the stack cannot under the circumstances be unfavorably criticised. Certainly the appearance of the structure was such as to warrant its removal, particularly because it had a decided lean, and its destruction in a storm would have crippled the adjacent filter plant, if it fell in one direction, or the pumping station, if it fell in another. Then, too, it is likely that if it had been allowed to remain, the footings would have needed reinforcement. The adverse criticism that lies in connection with the stack is against its first construction. It was built during a time of the year when anyone should have anticipated that a first-class job was impossible.

Railroad's Trade Campaign

THE Lehigh Valley Railroad is alive to the trade opportunities in South America. Recently there appeared a carefully prepared 51-page pamphlet on the subject issued by the company's traffic department. A preface of eight pages on the general conditions and governmental requirements is followed by detailed statistical data relative to the individual countries, their population, resources, imports and the like. There is also much miscellaneous information as to shipping details, postal requirements and other matters. This week the company has been spreading the information contained in the pamphlet by means of a demonstration train, which left New York Monday and arrived in Buffalo Friday. Three speakers, especially qualified, were aboard—Charles M. Pepper and Edward Albes of the Pan-American Union, and W. S. Kies, who is in charge of the South American branches of the National City Bank of New York. Meetings were held at ten places, and an effort was made at each meeting to present information applicable to the main industries of the town. Trade promotion is as profitable to the railroads as to other lines of business, and so alert are their industrial departments that only some new combination of circumstances is needed to cause the running of a trade-boosting train even more novel than that referred to here.

Harrisburg Filter Decision

THE case of the New York Continental Jewell Filtration Company vs. the City of Harrisburg, which involves the negative head patents and has been in court since 1908, was decided, on appeal, in favor of the city, Sept. 15. A review of Judge Hunt's opinion appears on page 344. It is evident that the decision has no direct effect upon the general status of the negative head patents, for the court is specific in stating that, while the city of Harrisburg does not infringe, "we do not feel bound to go to the length of declaring the patents invalid." The ruling, therefore, deals only with a specific case where infringement was claimed and can not be applied to mechanical filter plants generally, although it can not be doubted that the moral effect of the decision will strengthen the cases of other cities involved in similar litigation. It is apparent that the court, in reaching its conclusion, laid great stress upon the tests which James H. Fuertes, consulting engineer, conducted at one of the Harrisburg beds. Gages were introduced at various levels in the sand and it was shown that a partial vacuum existed only during a small percentage of the time the unit was in operation. This evidence, Judge Hunt points out, controverts the claims of the filter company, but apparently less significance was attached to it by the lower court than by the Court of Appeals. The Harrisburg case is disappointing to the waterworks engineer, for it still leaves in doubt the question of the validity of the negative head patent.

The Filibuster Succeeds

AFTER one of the most strenuous fights known in recent senatorial history, Senator Burton and his colleagues have succeeded in their attack upon the River and Harbor Bill. As it was under consideration in the Senate, the measure carried $53,000,000, but the filibuster forced it back to the committee with instructions to report a new bill carrying a total not to exceed $20,000,000. The committee acted promptly and within 24 hours the Senate, by acclamation, adopted the measure, sending it to the House for consideration. There is moral certainty that the representatives will accept the measure. The chief cause for congratulation is not that the appropriation was reduced by $33,000,000—certainly not a minor matter—but that full power over the apportionment of the $20,000,000 appropriated has been placed in the hands of the Secretary of War and the Chief of Engineers. They will decide on what projects the money is to be spent. Thus as one stroke has the appropriation been reduced and the "pork" eliminated. Senator Burton is to be heartily congratulated. More than that he has deserved the gratitude of the country.

Highway Instruction Pamphlet

A WORD of welcome is due three modest pamphlets recently issued by the Pennsylvania State Highway Department. It is, indeed, all that would be necessary, were it not that many worthy contributions to road literature are accorded but a scant measure of publicity as compared with publications less thoughtful but more skillfully advertised. One of the Pennsylvania bulletins deals with drainage, another gives instruction for road supervisors and the third contains drawings of the standard structures evolved by the department. The first gives a brief summary of points of good practice regarding a road-making essential second to none, the second gives a straightforward, concise statement of the supervisor's duties and all three reflect the successful experimentation of a large and active bureau. Frankness is a marked quality of the drainage bulletin. The pamphlets are a valuable step in raising road standards in Pennsylvania. If good judgment be exercised in their use they will greatly aid the roadbuilder in his labors.

Measuring Flow in Open Channels

THE screen method for the measurement of flow in open channels is recognized as giving results more correct than those generally used. In its original form, as devised by Prof. Eric Andersson, of Stockholm, Sweden, it has been described in textbooks, but later improvements have not before been brought to the attention of engineers. The article in the last issue, therefore, deserves careful study. Furthermore, the successful manipulation of a large screen justifies the expectation that this method before long will replace all others, when it is desired to measure slowly moving bodies of water in channels of uniform cross-section. The only other method by which equally accurate results can be obtained is the chemical, but the difficulty of obtaining a perfect mix between the initial solution and a slowly moving body of water prevents its general adoption. In the case described in the article a turbine was to be tested. The chemical method would have been feasible because a perfect mix would have been obtained when the discharge passed through the runner and the draft-tube. As the apparatus for injecting the initial solution is rather costly, however, it is doubtful whether the screen method was not the cheaper.

The Reinforcement Schedule

CONSIDERABLE emphasis is laid in engineering schools on the necessity of avoiding the use of specials whenever standard shapes and sizes will answer. The lesson, however, is evidently not thoroughly learned until the young man's designs after graduation have been checked by an experienced chief and sent back for correction because unstocked materials are called for. Probably in the purchasing of reinforcement bars there is less consideration of commercial factors than in other lines. This is due likely to the fact that many of our concrete designers left college before there were courses in this specialty and because reinforcement does not, like steel shapes, lend itself readily to the making of a handbook. The experience of those dealing in reinforcement bars show that considerable economy could be effected in the actual cost of the metal and in time, through expediting deliveries, were fabricating factors more generally recognized. Attention is, therefore, directed to the article on page 356 of this issue. In it Mr. Mellor shows that the cost of the reinforcement can be reduced to a minimum—reduced, of course, without skinning or injury to the design—by so selecting sizes, lengths and chemical and physical properties that the order will fit in most readily with the mill schedule or be drawn entirely from stock.

Uniform Filtration Statistics

EVER since the New England Waterworks Association made its pioneer move last year by appointing a committee to study the subject of statistics of water purification plants, filter operators have been looking forward to the publication of the first report. It is probable, therefore, that the recommendations presented by the chairman, George C. Whipple, at the recent Boston convention of the association will be widely read and adopted. The committee has divided its subject into five topics—descriptive data, statistics of analyses, engineering statistics, financial statistics and vital statistics. The report considers only the first two topics. As to descriptive data, the committee finds that most published accounts of plants are incomplete, and to remedy the difficulty presents a list of specific subjects (see page 329 of last issue) upon which information is essential. In its efforts to bring order out of the present chaos in statistics of analyses the committee has prepared seven standard forms for reporting results. These are arranged to show the analytical data by months and years. It is concluded that the determination of nitrogen in the usual forms of free and albuminoid ammonia, nitrites and nitrates serves no particular purpose in water purification except in special cases. Another encumbrance which is marked for deletion is the term "percentage removal of bacteria," which is so susceptible of misuse that the committee recommends its omission from official reports of filter operation. Under present conditions of reporting operating results it is extremely difficult, if not impossible, to compare one plant with another. It is by the interchange of information that the art of water purification will be advanced, and in simplifying the means of this exchange the committee will have rendered a signal service to the profession.

Broken Sprinklers at Salem

AUTOMATIC sprinklers have proved such an effective means of preventing the spread of fire that no one will deny their usefulness, but responsibility does not end with the mere installation of these devices. This fact will be appreciated by a careful reading of the paper in the last issue of this journal, written by Frank A. McInnes and Clarence Goldsmith, of the Boston Water Department. It was not long, according to their account, before the pressure in the 20-in. distribution main near the origin of the fire was reduced to such an extent that the engines were unable to get enough water to pump. At no time was the quantity pumped in excess of 2500 gal. per minute, although tests of the system after the conflagration showed a flow of 8585 gal. per minute. Broken sprinkler connections are blamed for the water shortage. The collapse of two buildings near the 20-in. supply main shattered sprinkler piping fed by one 8-in. and two 6-in. connections, allowing water to run to waste at the rate of 7200 gal. per minute, a quantity in excess of the entire supply required for the protection of a city the size of Salem. There is a moral here for every waterworks engineer. When the breakage of the connections to sprinklered risks can demoralize the fire-fighting service of a city in less than half an hour, it is evident that adequate means should be provided for shutting off the waste flow through these outlets after their usefulness has been destroyed. The lesson to be learned, therefore, is not that the automatic sprinkler system is ineffective in reducing the fire hazard, but that it should be capable of being cut off from the city mains after a break in the piping allows water to run to waste which is urgently needed elsewhere.

False Economy

NOW that there is a hue and cry for economy the country over, we may expect attempts to gain popular favor for proposed legislative measures under the slogan of "Reduction in Expenditure." True economy affects an ultimate saving and is not to be confused with penny wise and pound foolish policies. Engineers are all too familiar with the fallacy of attempting a saving by cutting down the allotment for engineering services, but it is not often that this narrow policy appears in matters controlled by state authorities, where a certain amount of foresightedness is expected. Oregon, however, is open to severe criticism for proposing to abolish the office of the State engineer, which is the evident purpose of a measure now before the people, to be approved or rejected at the November election. The proposed measure provides for radical changes in the handling of water-right applications and creates the appointive position of water commissioner. It provides that the engineer in charge of the Tumalo irrigation project shall assume, in addition to his present duties and without increased pay, the work of the State engineer's office until 1916, after which time these duties shall be discharged by an appointee of the State Land Board. The most radical feature of the measure, however, is the proposed discontinuance of the annual appropriation of $59,400, which supports the offices and the work of the State Water Board and the State engineer.

However urgent may be the need for economy in carrying on Oregon's state affairs, the sudden stoppage of funds for carrying out the work of the water board would be unwarranted, and the proposed institution of a radically different and untried method of handling the applications for the use of water for irrigation and power purposes cannot be too strongly condemned. Oregon's present water code is one of the best, if not the very best, in the West, but it is agreed that its success depends upon administration by a single executive head, who can be held responsible. Indeed, in addition to destroying the effectiveness of the present system, the abolition of the office of State engineer would very likely bring about a chaotic condition in the administration of water rights. Stopping the appropriation for the State Water Board would stop the investigation of water resources, stream flow measurements and the compiling of data for topographic and geologic maps. The Federal Government pays for half this work, share and share alike, with the State. When the State ceases to allot funds, the Government appropriations will cease automatically. This would be especially regrettable in the case of Oregon, which is considerably behind the average in the compilation of official maps, only about one-fourth of the State having been covered.

It is gratifying to note that a definite stand against this measure has been publicly taken by the Portland Association of Members of the American Society of Civil Engineers and the Oregon Society of Engineers.

Have South American Trade Possibilities Been Overestimated

RANKING as an authority in economics, having been honored with the presidency of the American Economic Association, and being qualified by an extensive investigation in South America, Dr. Kinley speaks with authority in the article on page 353 of this issue. The limitations to possible American expansion in South America have been previously pointed out in these columns, but at no time so clearly as is done by Dr. Kinley. One of the factors given least attention is the limitation imposed by our inability to take food products in exchange for our manufactures. But even granting that inability and making allowances for the superior advantages afforded those countries which can finance enterprises in South America, Dr. Kinley nevertheless concludes that "the market open to us on account of the war is a tremendous one and very much larger than we shall be able to supply."

That American manufacturers are not deceiving themselves as to the opportunities is apparent from a sheaf of letters received by this journal from manufacturers of engineering and construction materials, in answer to requests for information as to what they were doing to develop South American trade. Fully half of the 150 replies received show that careful investigations are being made. In many cases the manufacturers express themselves as being convinced of the opportunities, but add that they are restraining their enthusiasm until competent investigation has placed them in possession of full information. In two cases the position was taken that we have grown over-enthusiastic and that not enough consideration is being given to the present financial condition of South America, the need for adequate exchange facilities and other factors which prevent rapid, immediate expansion. This journal is of the opinion, however, contrary to the views of these two manufacturers, that American business men are not losing their heads over the situation or painting the picture too rosily. If anything the tone is too conservative. While it may be true that the press in some cases has been over-enthusiastic, its attitude has at most only served to awaken the phlegmatic to a realization of the fact that a continent awaiting development lies to the south. Possibly only over-enthusiasm could do this.

One passage in Dr. Kinley's article is especially worth noting. He says, "There is too much talk of Government initiative in this matter. . . . Countries do not trade. Business firms and individuals trade. If, therefore, any manufacturer or group of manufacturers is in earnest about developing trade with South America he must proceed of his own initiative." This means that one cannot expect to get from the Department of Commerce at Washington all of the information necessary for planning upon trade expansion in South America. Recourse to other sources, to exporting agents who have thoroughly canvassed the trade, to the National Foreign Trade Council and to similar agencies which are giving especial attention to the problem is necessary. If the data secured indicate a present opportunity for the particular product under consideration, an investigation in South America, either personally or through a reputable house with agencies there will be needed before the active campaign is undertaken. One of the best modes of procedure is for half a dozen non-competing houses to band together and employ a competent representative, speaking Spanish and Portuguese, to go to South America. It will be for him to engage local agents. Already these groups are forming. Given a satisfactory preliminary study—demonstrating unmistakably a market for the product—and a capable representative to engage agents, the opportunities are decidedly inviting.

War Engineering

DESPITE a thorough censorship, enough information has leaked through from the Continental war to show that some notable engineering feats are being carried out, especially by the German military engineers. Doubtless the Allies will show an equal efficiency when the time comes. But the brunt of the engineering work has fallen on the Germans in making provision for transporting through hostile territory and over all sorts of obstacles the materials of war for an army variously estimated at from one and a half to two and a half million men. In the Allies' retreat bridges were blown up, railways destroyed, culverts and embankments wrecked and everything else done to interfere with the transportation facilities. Apparently the German engineers have been successful in repairing damages on very short notice and some striking instances are given of their replacement of wrecked bridges to let through the supply trains.

Perhaps the most sensational engineering feature of the struggle, however, has been in connection with the transportation and service of the heavy German siege artillery. It was doubtless known in some military circles, but certainly was unknown to the general public, that the German forces possessed a siege howitzer with the enormous bore of 16½ in. (42 cm.). These and heavy pieces of somewhat smaller calibre have been put into service freely during the rapid advance. That the Germans had a seacoast gun of this calibre was of course well known, since the Krupp's exhibited one at the Chicago exposition more than twenty years ago, but a piece of 42-cm. bore, reduced to a weight permissible in a siege train, is something of a novelty and its transport is very much of an engineering feat. The weight of the piece is not definitely known, but is probably not less than forty tons for the piece alone, and at least as much more for the carriage, basing this estimate on the known feasible ratio between the weight of the projectile and that of the piece as found in more ordinary calibres. Such a weight agrees well with the factors of safety of light siege howitzers in general, and could not be materially reduced even by the use of special steels, except at the cost of considerable increase in the weight of the carriage and the arrangements for taking up the recoil. The projectile weighs a little over a ton, according to the best information available, and this again would agree fairly well with the weight stated. The sea-coast gun of this calibre weighs one hundred and twenty tons for the barrel and breech closure alone. The 21 and 24-cm siege pieces, well known in the German service, weigh with carriages and foundation something like seven to ten tons.

The transportation of these guns, with adequate ammunition supply, is a staggering task. Special freight cars, on account of light German standards, are required to accommodate the weights, even though the barrel is shipped separately from the carriage. At the end of railway transportation the troubles with the smaller guns have just begun, for some means has to be provided for dragging them over roads already torn up by heavy service or blown up to impede progress. Motor tractors are said to be ordinarily the means taken for dragging the huge weights, but even with this advantage getting them over the road with any degree of promptness and following them up with enough rounds of ammunition to be of any service is a task which must keep the engineering forces extremely busy.

One thinks at first of battles being won mainly on the firing line, but in the long run they are decided by the condition of the line of communication. A few hours lost in bringing up a siege train may mean retreat, and a single swoop on the line of supply of an invading army is more than likely to bring fatal disaster. And in this particular war the engineers are hard pressed to move so quickly along unexpected lines of operation as properly to back up the fighting force with materials. Doubtless the German general staff, having long planned the invasion of France via Belgium, had contingencies like the destruction of bridges in Belgium and northern France so far provided for that material was at hand. Nevertheless, the transportation of the colossal siege artillery is a truly Herculean task.

AN IMPROVED HAWAIIAN ROAD IN THE KOLEKOLE GULCH

Recent Road Improvements in Hawaii

Construction in Territory where Rainfall is Excessive and where Soil Overlies Lava Rock—Maintenance with Asphaltic Oils—Culverts and Bridges

By M. J. ADAMS

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LOCAL conditions separate the island of Hawaii into several distinct and more or less isolated districts. The entire central portion of the island is taken up by mountain masses rising to nearly 14,000 ft. in height at the two principal summits, Mauna Kea and Mauna Loa, and to 8000 ft. for Mount Hualalai on the west side. Mauna Loa is an active volcano at average intervals of from five to seven years. Although the island has an area nearly equal to that of the State of Connecticut, because of climate and soil conditions only a narrow belt near the coast is actively productive. Therefore, there is only one road of importance, the Belt Road, which encircles the island near the coast. The two outlying districts of Puna and Kohala, which are not included within the encircled area, are connected to the Belt Road by spurs.

For several years and until recent improvements were made by the Hawaii Loan Fund Commission the districts were separated by road conditions which discouraged traffic and stifled development. In general no one considered making a trip from one district to another if it could be avoided.

The Legislature of 1911 passed the loan fund act, by the provisions of which various sums were appropriated for public improvements, to be spent by a commission for each county. Each commission was to be composed of the superintendent of public works of the Territory, the chairman of the county board of supervisors and three citizens of the county. For the county of Hawaii there was appropriated $500,000 for the improvement of the Belt Road and bridges. The funds were to be provided by the sale of 30-year Territorial bonds. All work was to be done by contract. The commission selected for improvement the very worst sections, two of which were impassable during parts of the rainy season and all of which were but little better than trails with an exceedingly rough surface, deep potholes and serious faults in alignment and grade.

In general the climatic conditions are semi-tropical. On the windward side the rainfall is very heavy. Yearly totals of 150 in. are common at the coast, with totals of 250 in. above the forest line, a few miles inland. Owing to the amount of rainfall there has been considerable erosion. Gulches from 100 to 1000 ft. wide and 50 to 300 ft. deep occur at frequent intervals. Into these the road descends on a cut out bench to a point where a crossing of the stream is practicable and then ascends the other side.

Soil Overlying Lava

In general, the soil along the greater part of the windward coast is from 6 to 8 ft. in depth overlying the lava rock. It varies a great deal, however, and a cut which it was thought would be 90 per cent rock may be that much in earth or vice versa. The soil is a brownish red in color. It resembles clay but differs radically from clay in some respects. In some localities the top soil is friable during dry weather and must be cut to 1 : 1 slopes, but many deep cuts in earth are left with slopes of 4 : 1 and 2 : 1. Slides are apt to occur, caused either by an earthquake or a heavy rain after a continued dry spell, but the slides seem to be independent of the slope and are nearly as apt to occur in old slopes as in new. Many instances may be seen where a flume ditch or drainage ditch has been turned through an unprotected cut in the soil, on very steep grades, and flows for years with no erosion to speak of. A large part of the excavating is performed by fluming.

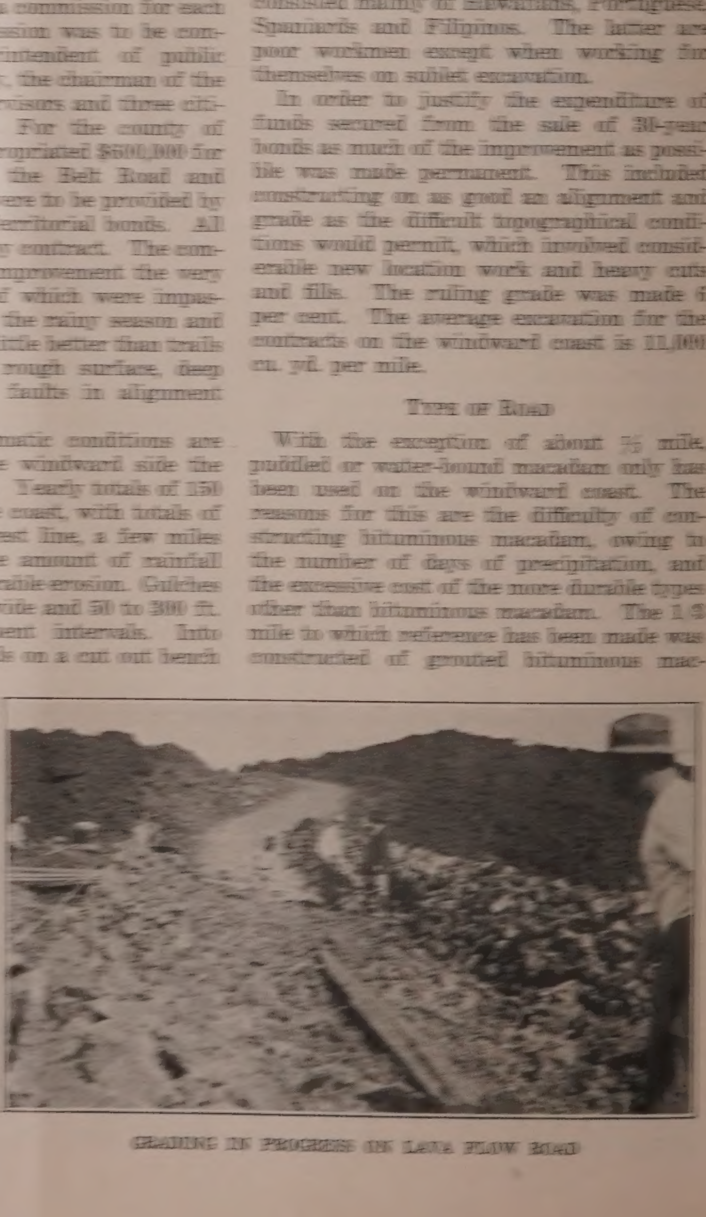
Making a fill under traffic during the rainy season is a discouraging proposition. Even though the fill be made with a very high percentage of rock from excavation the small amount of soil which adheres to each piece of rock, when wet, acts as a lubricant and a vehicle, particularly an automobile, may bury itself to the axles. The labor has consisted mainly of Hawaiians, Portuguese, Spaniards and Filipinos. The latter are poor workmen except when working for themselves on sublet excavation.

In order to justify the expenditure of funds secured from the sale of 30-year bonds as much of the improvement as possible was made permanent. This included constructing on as good an alignment and grade as the difficult topographical conditions would permit, which involved considerable new location work and heavy cuts and fills. The ruling grade was made 6 per cent. The average excavation for the contracts on the windward coast is 11,000 cu. yd. per mile.

Type of Road

With the exception of about ½ mile, puddled or water-bound macadam only has been used on the windward coast. The reasons for this are the difficulty of constructing bituminous macadam, owing to the number of days of precipitation, and the excessive cost of the more durable types other than bituminous macadam. The 1/2 mile to which reference has been made was constructed of grouted bituminous mac-

CONDITION OF OLD ROAD ON LAVA FLOW



GRADING IN PROGRESS ON LAVA FLOW ROAD

adam as an experiment. Although the weather at the time was abnormally dry there was enough delay, because of rain, to indicate that bituminous macadam would have added greatly to the cost, aside from the increased cost of material.

A 6-in. course of stone sub-base and 6 in. of macadam in two courses of 3 in. each were used. Owing to the extreme concentration of rainfall within short periods the amount of crown is of more than usual importance. A crown of ½ in. per foot for flat grades increasing to ¾ in. per foot for steep grades was found to give good results. In general the wear caused by weather conditions far exceeds the wear of traffic.

CULVERTS

On some portions of the work there had never been any drainage structures, the traffic crossing the bed of the channel. This, coupled with the fact that some of these same gulches have water in them only once in several years, made conditions difficult. In the latter class of gulches the ordinary rains, extending over periods of weeks at a time, are absorbed and the gulches flow only when there is a storm of cloud-burst proportions. They then require culvert areas of 100 sq. ft. or more. The average cost of drainage structures was $3,500 per mile, which is inclusive of those sections where the greater number of bridges and culverts were in place in fair condition and were retained.

Where the road follows down the sides of long gulches culverts were put in an average distance of 500 ft. apart. The small area culverts were constructed of concrete pipe in sizes of 18, 24, 30 and 36 in. The 18-in. size was originally made the minimum, so that it could be easily cleaned. On later contracts 24 in. was the minimum size. Spans of 4 to 8 ft. were, in general, made of the box type. Spans 8 to 20 ft. were made of slab and abutment type. Spans 20 to 40 ft. were made of deck-girder construction. Besides the standard types there was constructed one arch of 50-ft. span, a reinforced concrete truss bridge of 38-ft. span enclosing a steel bridge, and one viaduct 72 ft. overall.

BRIDGES

Four bridges of an average span of 70 ft. were constructed of wood. The reasons for this choice were as follows: Steel bridges are very short lived in this climate. It was deemed inexpedient to construct a concrete arch on any except solid rock foundations. The span could not be divided by concrete bents because of the great boulders brought down during freshets. Existing covered wooden bridges were in fair condition after twenty years of service except at the ends of the bottom chords where weeds and soil had been allowed to accumulate around them. A covered wooden bridge could be constructed at a fraction of the cost of a concrete structure.

All structures are designed for a 16-ton roller.

Owing to the unfavorable conditions all unit costs are quite high. For example, concrete costs range from an average price of $20 per cubic yard for 1:2:4 concrete to $14 per cubic yard for 1:3:6 embedded stone concrete.

ROAD MAINTENANCE

Although it was thought wise to construct of unoiled macadam it was realized that to get the best returns on the investment the new work should be maintained with some sort of bituminous application. After the first section of road constructed had been down 1½ years under a traffic of 100 vehicles per day, including eight auto trucks, and about equally divided between horse-drawn and auto traffic, sections of road aggregating 3600 lin. ft. were covered with a bituminous carpet as an object lesson to the county of this type of maintenance. This work was performed on grades of 1 to 6 per cent, but mostly on grades of 4 to 6 per cent, using two grades of asphalt and two grades of asphaltic oil, applied at the rate of 0.4 gal. per sq. yd. and covered with dustless screenings. The macadam surface was thoroughly swept.

The four materials used may be described briefly as a hard asphalt, penetration 5 mm; a soft asphalt, penetration 160 mm; a 90 per cent asphaltic oil and a 75 per cent asphaltic oil. Even with the smallest amount which could be applied by hand the 75 per cent asphaltic oil had a tendency to bleed excessively, and by the time enough cover had been applied to correct this the mat was too thick to give the best results, as there was a tendency to become mushy.

With the 90 per cent asphaltic oil, although it formed an apparently perfect mat, its adhesion to the macadam surface is not great enough, as there have been two or three instances where careless wagon drivers by locking their brakes and dragging their wheels have gouged the mat. The only drawback which I have noted to the use of a relatively hard asphalt is its tendency to become slippery.

After watching the results for four months, I am of the opinion that for future work of this kind, at this place a relatively hard asphalt should be used for grades up to 2 or 3 per cent and a softer asphalt or a 90 per cent asphaltic oil for steeper grades.

A road improvement which presented several unusual features was executed on the leeward side of the island, in the construction of 9.03 miles of grouted bituminous macadam across some of the more recent lava flows, including that of 1907. Although some pahoehoe or smooth flow was encountered the greater part was A A (ah-ah) or clinker flow.

Some 3 or 4 years previously the county had covered a short stretch of the flow with an earth filler which had compacted and worn very well. Before letting a contract for this stretch of lava flow the commission experimented further with earth filler. One of the local transportation companies kindly furnished an auto truck and driver, a small force of laborers was hired and the work was carried on for two weeks to arrive at a fair approximation of the cost of applying earth filler.

However, because of the fact that the only available source of supply was beyond one end of the contract, with a consequent long haul and the fact that the amount of filler in sight was limited, comparative bids showed the cost of earth filler to be very nearly the same as that of bituminous binder, so the latter was used.

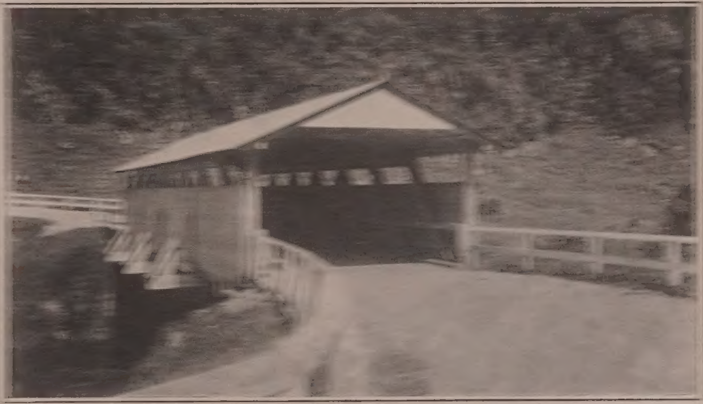
A short section was tried, merely adding the bituminous binder to the natural material as it occurred in the road. Owing to the average large size of the stone, the rounded condition of that in the ruts, the variety of sizes, and the occasional presence of dust pockets just under the upper layer, it was not deemed advisable to continue this method. With the exception above mentioned the 9.03 miles were constructed with a 2-in. broken stone macadam, top course only, bituminous binder grouted.

GRADING

The grading was a difficult and expensive piece of work. The greater part of the material handled was of such a nature that unless handled with due respect it would puncture the flesh. To walk over it would chew up a stout pair of shoes in a very short time. The frequent ridges were found to be composed, below a depth of a few feet, of the hardest kind of rock, which was difficult to blast on account of the frequent blow holes and pockets of loose material. Practically all excavated material was wasted and embankment borrowed, as it was considerably cheaper to do this than to move it.

As the greater part of the road is on long tangents with corresponding lengths of sight and as travel is infrequent, the width of macadam was made 10 ft. The ruling

APPEARANCE OF FINISHED MACADAM ON LAVA FLOW


TYPE OF STANDARD INCLOSED WOODEN BRIDGE

grades were reduced from 15 per cent to 9 per cent.

SPECIFICATIONS

There follow excerpts from the specifications for the top course macadam: After the subgrade has been brought to grade and thoroughly rolled, No. 3 stone (passing a 2½-in. ring, but retained by a 1¼-in. ring) shall be evenly spread to such a depth that the whole course shall have, when completed, the required thickness. The course shall be rolled with a self-propelled roller weighing at least 5 tons, until the surface is firm and compact, after which 1.5 gal. of bituminous material, as hereinafter specified, heated to a proper temperature, shall be evenly spread over each square yard of surface. Immediately thereafter ½ cu. ft. of dry No. 2 stone (passing a 1¼-in. ring, but retained by a ⅝-in. ring) per square yard, shall be evenly spread upon the surface to fill the voids, and be rolled until no more can be forced into the course. All loose material shall then be swept off. Next, 0.5 gal. of the bituminous material, heated to a proper temperature, shall be evenly spread over each square yard of surface; upon this shall immediately be spread ⅜ cu. ft. of dry dustless screenings for each square yard of surface and the rolling be continued until a firm, smooth surface results, conforming with the plan in longitudinal and transverse section. This wearing surface shall be maintained and renewed if necessary, until the entire work has been accepted, and if more than one renewal is required stone dust will be permitted for subsequent renewals.

It was specified that the stone used should be the best obtainable from the flow. This is a lightweight lava rock with a number of small holes. Because of this the quantity of asphalt used was raised from the 1.65 gal. originally specified to 2 gal. per square yard. The asphalt used showed the following characteristics:

Homogeneous	Yes
Gravity at 77° F.	1.03
Penetration at 77° F.	5
Per cent loss on heating at 325°	Trace
Per cent Bitumen soluble in CS_2	99.3
Seventy-six per cent naphtha	74.0
Carbon tetrachlorides	99.4
Per cent. fixed carbon	19.2
Open flash	560°
Melting point	142°F

The road was constructed by hauling over the finished work. Owing to the condition of the sub-grade and the fact that all fills were retained by slope walls a light-weight roller was specified.

During the progress of the work it was found that, owing to the light weight of the stone and its brittleness, and the condition of the sub-grade, it was possible to pass the roller only once or twice over the loose stone, before the application of the bituminous material. If more than this was done the roller worked down through and pushed the stone in waves. The course was thoroughly rolled after each application of asphalt.

CONTRACTOR'S PLANT

All water for camp purposes and stock had to be hauled an average distance of 8 miles. The asphalt and all camp supplies had to be hauled an average distance of 18 miles from the nearest port and up a difference in elevation of 1800 ft., the most of which occurs in a succession of long grades of 6 to 8 per cent.

The main features of the contractor's plant were: one 5-ton gasoline dumping truck; one 3-ton gasoline platform truck; one light runabout with delivery body; one 30-ton per day jaw crusher later replaced by a 60-ton per day gyratory crusher; one 7-ton gasoline roller; 800-gal. capacity heating tank; store, camps, etc. The 5-ton truck was used for hauling macadam stone and the platform truck for hauling asphalt and supplies, frequently working far into the night.

The first few miles of the road stood the continuous traffic of the 3-ton truck and some traffic of the 5-ton truck for 10 months, practically without a mark. Beyond that, largely owing to the fact that there was no fine material in the loose sub-grade to help bind it, there was rutting and occasional breaking through the road crust. These places were successfully patched and beyond a slight waving, which is not objectionable except to a short-bodied car moving at high speed, the finished road is in good shape. This improvement cost about $54,000.

The early stages of the work of the Hawaii Loan Fund Commission were in charge of H. K. Bishop, chief engineer, who was succeeded by the writer.

Harrisburg Mechanical Filters Do Not Infringe Negative Head Patents

Judge Hunt, in U. S. Circuit Court of Appeals, Decides Long-Standing Case in City's Favor But Makes No Ruling on Validity of Patents in General

WITHOUT denying in general the validity of the Jewell negative head filter patents, Judge Hunt in the United States Circuit Court of Appeals on Sept. 15 handed down a decision in the long-standing case of the New York Continental Jewell Filtration Company vs. the City of Harrisburg, Pa., which reverses the decree of the lower Court (see Engineering Record, Sept. 13, 1913, page 287), and declares that in the specific case of Harrisburg, the city has not infringed the patents in question. In rendering the decision the Court, apparently, gave weight to the results of six months' tests with pressure gages, of one of the Harrisburg filter units where it was shown that a partial vacuum in the bed existed only during a small percentage of the time, generally near the end of a run. Judge Hunt says: "It is probably enough to say that, at the best, the evidence in behalf of the company leaves us in much uncertainty whether the theories of the patents are sound. We do not feel bound to go to the length of declaring the patents invalid—the reissue patent, indeed, has already expired, leaving the patentee only a claim for royalties—but we are fully prepared to say that while the subject is so surrounded by uncertainty the company cannot reasonably object to the application of a test that tries the Harrisburg filters by the theories of the patents. If these filters do not produce the results called for by these theories it is certainly fair to conclude that the company has not succeeded in making out the charge of infringement."

TESTS OF VACUUM

The Court then cites the experiments at Harrisburg conducted under the direction of James H. Fuertes, consulting engineer, in which the filters were provided with a series of gages to indicate the pressure at seven levels in the water, sand, gravel, and outflow pipes. The test lasted six months and the results, offered in evidence, and included in Judge Hunt's opinion, showed that "a partial vacuum never came into being at or near the beginning of a run; that 191 runs out of 256, or about 75 per cent of the whole, did not show a partial vacuum at all, and that while 65 runs, or about 25 per cent showed a partial vacuum, they did not show it until near the end of the run. Further, of these 65 runs in which a partial vacuum appeared near the end of the run, it appeared at the bottom in only 8, while in the remaining 57 it appeared in different places, sometimes at the top of the bed, sometimes at varying levels between the bottom and the top. To state the matter from another point of view, during the whole experiment the records show that a partial vacuum appeared first at the bottom and remained greatest in that part of the bed during only 115 min., or for only about 0.06 of 1 per cent of the time during which the filter was in operation."

The opinion starts with a brief statement of the claims of the patents in suit and follows with a general discussion of the principles of filtration and the state of the art. A very extended review of the language of the various patents referred to in the suit is then given, followed by a discussion of the principles of suction as applied to this case. The Court points out various patents which were cited by the city as anticipations of the patents in suit and reviews in this connection several instances of prior use claimed by the city, and proceeds then to a discussion of the scientific principles involved in the patents in suit and the theories of the patents as disclosed by the evidence. Excerpts from Judge Hunt's opinion follow:

SUCTION

The basis of the decision of the District Court, reversed by Judge Hunt, was that in Jewell's patent a pull of suction exists whereby a pulling force is created upon the material in the bottom of the filter, and that the use of such suction action tends to release air from the water which may be of advantage, and also tends to cause the sand grains in the vicinity of the strainer system to reseat themselves, and thereby compacts the section of the bed. In his opinion, among other things, the learned Judge [Buffington] said: "That the process and apparatus disclosed by Jewell * * * do in practical use by the creation of a vacuum utilize the whole sand body as a filtering agency as it was never used before. Indeed, that the workings of a downdraft or negative filter must in the nature of things be different from a gravity or positive head filter is self-evident from the fact of its calling into play the powerful agency of atmospheric pressure. From this we can readily understand that such atmospheric force, whether venting itself as a weight from above or a suction from below, must cause new results in a process, the basic element of which is the pressure passage of liquid through impeding matter."

Thus the reasoning of the Court was in effect that the process and theories disclosed by Jewell in his patent in practical use did, by the creation of a vacuum, utilize the whole sand body as a filtering agency as it had not been used before, and that the Jewell process does by the use of a downdraft, sealed, vertical outlet pipe create and maintain an operative vacuum, which vacuum effects a deeper utilization of the sand body for filtration than in positive head filters; that the presence of a released air incident to the use of a downdraft vacuum is helpful and not harmful by reason of the velocity imparted to the passing water by such vacuum; that the process makes the runs longer, and that both structural and maintenance costs are lessened by its use.

Now it appears that in the art of filtration, it has been the practice, when it is desired to lengthen the run of a filter or to obtain the more rapid passage of the liquid through the filtering material, to utilize atmospheric pressure upon the liquid by creating a partial vacuum within or under the filter, in this way unbalancing the atmospheric pressure which had previously been equal on both sides of the liquid. The way of accomplishing this is called "suction," and in the language of the patents in suit is described as "suction from below."

Priority of Patents

Application of this way has been accomplished in filters of many kinds. Without going into greater detail it is clear that for many years before Jewell went into the field there were filters with granular filter beds having exposed filtering surfaces with means for producing a partial vacuum in the filter bed and the actual application of suction from below as well as means for reversing the flow of water through the filter. It therefore seems certain that nothing new can be claimed for "suction," or the creation of a partial vacuum within or beneath a filter bed. Again, the compacting of the filter bed greater at the bottom was described in the patent issued to Hyatt, No. 293,745, and as a means employed to produce "suction" there are instances in which a trapped downdraft pipe has been used.

The "pulling of suction" theory does not stand under critical examination, however, for the testimony of scientific witnesses proves that the operative force of what is commonly called "suction" is not a pulling, but is atmospheric pressure exerted upon the liquid or other movable material to the extent of the difference of pressure upon the opposite sides of the movable material; that is to say, the operative force is unbalanced atmospheric pressure, and this atmospheric pressure acts in the direction of the area of diminished pressure so it becomes a pushing force. It is proved that a partial vacuum is not made when the filter begins operation; nor is it shown that such vacuum is always greatest at the bottom of the bed. We are agreed, however, said Judge Hunt, that when we weigh the evidence of one side against the other it is highly probable that the lower part of the bed is but little affected by the so-called "pull of suction," and that there is but very little compacting by compression of the grains of sand, or by the sand grains moving because of the superincumbent weight of water and air. Moreover, such compacting of the lower part of the bed as occurs under the weight of water and air is not peculiar to filters operating under negative head.

Moreover, we think it is true that compacting due to overlying weight or to the downward flow of water is not the compacting contemplated by the patents. And, after a mechanical filter has been washed by a reverse current of water and air the sand is finest and most compact at the top, because the bed must then rearrange itself in accordance with the subsiding values of the grains. Misconception of the principle of "suction" has destroyed appellee's case, for it is the real foundation thereof.

With regard to the liberation of air in the bed and its usefulness there as a "coagulant," the weight of the evidence seems to indicate that air does not of itself act as a coagulant, and that its presence in a filter-bed is almost always objectionable.

There is one piece of evidence that is not referred to by the District Court, but in our opinion is of decisive weight upon the issue of infringement. We mean the prolonged experiment that was made with the Harrisburg filters. [The results of the experiment referred to are given in the second paragraph of this article.] It is not easy to exaggerate the value of these carefully conducted experiments, and we think it within bounds to say that, while the Harrisburg filters are charged with infringement, it is remarkable that their customary operation during six months failed to show the characteristics that are asserted to be inseparable from the apparatus and the method of the patents. No counter experiments were made, and no serious attack was made upon these records, or upon the conclusions they seem to justify.

Decree Reversed

In our opinion, therefore, the case may safely be decided by finding upon the evidence that the city has not infringed either patent. We therefore reverse the decree with costs, and direct the District Court to dismiss the bill.

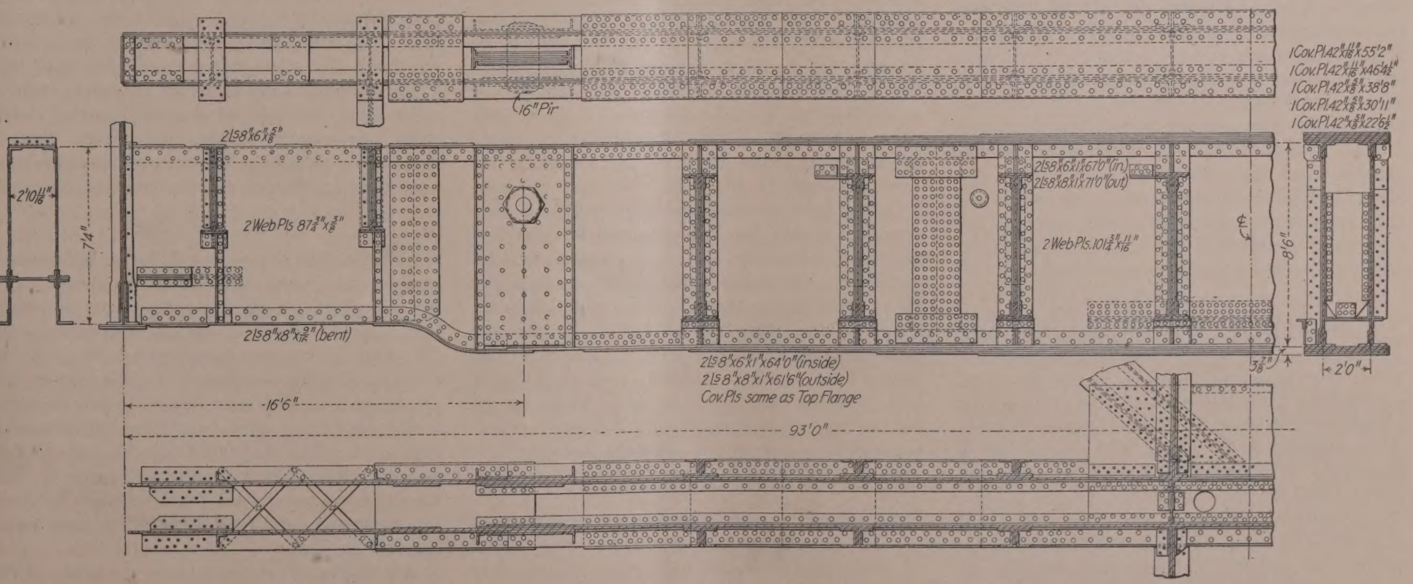
Hell Gate Arch Bridge Floor

Box Girders 9 Feet Deep Carry Four-Track Suspended Platform 93 Feet Wide, with Ballasted Concrete Track Slabs

UNUSUAL features of the single-deck four-track floor of the Hell Gate arch bridge over the East River in New York City include the length and box-girder section of the floorbeams and their suspension below the bottom chords of the arch trusses for a large part of the span. The main dimensions of the bridge were described in the Engineering Record of June 27, page 734, and details of the arch were set forth in the issue of Sept. 12, page 298. The horizontal roadway platform intersects the bottom chords of the arch trusses at the third panel points from the skewbacks, and between these points is suspended by vertical members from the intermediate lower-chord panel points $42\frac{1}{2}$ ft. apart. The floorbeams project $16\frac{1}{2}$ ft. beyond the centers of the trusses on both ends, and their extremities are connected by longitudinal horizontal members forming the chords of a wind truss with X-brace laterals between alternate floorbeams. At the ends of the span the floorbeams are connected directly to the truss members through vertical field-riveted hitch-angles. In the middle of the span the vertical suspenders pass between the double webs of the floorbeams and are connected to them by pins 16 in. in diameter and 60 ft. apart.

Suspended Floorbeams

The suspended floorbeams are double cantilever box girders 93 ft. long and about 9 ft. deep over all in the middle. They are symmetrical about the center line and are



DETAILS OF BOX-GIRDER FLOORBEAM FOR HELL GATE BRIDGE, SHOWING PIN CONNECTIONS FOR VERTICAL SUSPENDERS proportioned for a load of 275,000 lb. at each of the eight-track stringer connections, and one of 67,000 lb. at each of the four outside stringer connections. Each of them is made of a pair of plate girders with their webs 24 in. apart and their top and bottom flanges connected by 48-in. cover plates riveted through both inside and outside angles. The bottom flange angles are bent to a reversed curve on account of the diminished depth of the cantilever extensions of the girders. The webs are shop spliced in four places and are connected by vertical transverse diaphragms in the lines of the stringers. Outside the trusses the cover plates are omitted and the flanges of the cantilever ends of the girders are connected by lattice bars. Horizontal connection angles and plates are riveted to the lower parts of the webs at the middle and ends to afford attachment for the lateral diagonals.

Each track is proportioned for a live load consisting of two E-60 locomotives followed by a 6000-lb. train load, and for impact. This loading developed a calculated maximum moment of 28,900,000 ft.-lb. and 1,705,000 lb. of maximum shear. The suspended floorbeams weigh 86 tons each and are shipped complete from the bridge shop.

TRACKS

Where the floor intersects the lower chords the floorbeams, L6, are cut to clear the trusses and are field riveted through hitch angles to the webs of the lower chords. The floorbeam brackets are riveted to the outer faces of the lower chords, and the brackets and floorbeams are connected by horizontal tension rods passing through holes in the chord webs. The thrust in the lower part of the cantilever bracket is transmitted to the floorbeam through diaphragms connecting the lower-chord webs. Each pair of the track stringers, which are 6 ft. deep and 6½ ft. apart, carry on their top flanges 8-in. transverse I-beams 15 in. apart, which support reinforced-concrete trough-shaped deck slabs filled with ballast, in which standard track is laid. The decks for each track are independent and do not cross the floorbeams, where the rails are laid directly on the top flanges.

Samuel Rea is president of the New York Connecting Railroad. Gustav Lindenthal, consulting engineer and architect, designed the bridge and is acting as chief engineer of its construction. O. H. Ammann is assistant chief engineer and H. W. Hudson is construction engineer. The American Bridge Company is contractor for the fabrication and erection of the steelwork, the P. Ryan Construction Corporation is the contractor for the tower bases, the Snare & Triest Company is the contractor for the towers, and the deep foundations for the Ward's Island tower were constructed by the railway company on force account under the direction of Mr. Lindenthal, P. G. Brown acting as managing engineer.

A HOME-MADE WATERWHEEL has been installed by one of the farmers on the Salt River Reclamation Project in Arizona, according to the September issue of the "Reclamation Record." Two buggy wheels, placed about 8 in. apart and connected at intervals at the rims by 10-in. paddles, serve to generate the power, which is used for domestic purposes. Fixed on a leverage the wheel may be lowered into the water of the irrigation canal whenever wanted for use. At other times it hangs high and dry.

How the Wood-Preserving Industry Can Avoid Injury Resulting from the War

Seven Suggestions Which if Followed Out Would Probably Entirely Eliminate Dependence on Europe for 60 Per Cent of Our Creosote

By CLYDE H. TEESDALE
In Charge of Wood Preservation, U. S. Forest Products Laboratory, Madison, Wis.

THE present European situation has had a very serious effect upon the wood-preservation industry in this country. At the beginning of 1914 there were ninety-four treating plants in the United States, with an aggregate annual capacity of more than 300,000,000 cu. ft. of timber. Actually 153,613,888 cu. ft. were treated in 1913. Of this, more than 106,000,000 cu. ft. were treated with creosote, 36,000,000 cu. ft. with zinc chloride and 8,000,000 cu. ft. with a mixture of creosote and zinc chloride. A total of more than 108,373,000 gal. of creosote was consumed, of which 41,700,000 gal. were produced in this country and 66,673,000 gal., or 62 per cent, were imported, principally from Germany and England. The present crisis in Europe has cut off entirely the supply of oil from Germany, and much of that from England, and consequently a very serious shortage is imminent.

The principal sources of coal tar, from which creosote is produced, are bi-product coke ovens, and gas plants which produce illuminating gas from coal. A large amount of coke is being produced in the old beehive type of oven, from which the tar cannot be recovered. A very considerable amount of tar is also burned by gas-house plants, or is allowed to run to waste. If all of the coke produced in this country were made in bi-product plants and the creosote recovered, and if that now wasted by gas-house plants were made into creosote, this country would be independent of the European production. It seems very unlikely, however, that this situation can be brought about for many years. The question confronting the industry is how to avoid the possible result of a great reduction in the amount of timber treated, and apparently two courses are open: (1) The use of substitutes for creosote; (2) lighter treatments where creosote must be used.

ZINC CHLORIDE

The best known preservative that could be substituted is zinc chloride. The value of this preservative has been thoroughly tested during the past eighty years. In some situations it does not add as much to the life of timber as creosote, and with the prices which have prevailed the annual charge against creosoted crossties has been less than against those treated with zinc chloride. The accompanying table (from Forest Service Bulletin 118) gives the estimated saving due to the treatment of ties with preservatives.

In this table creosote was assumed to cost about 8 cents per gallon, placement in the track 15 cents per tie, and tieplates 25 cents per tie with interest charges at 5 per cent. Should the present situation result in a material increase in the price of creosote it is obvious that the annual charge for ties treated with zinc chloride would become the lower, and its substitution, to a large degree, for creosote would be warranted on the basis of cost.

ESTIMATED ANNUAL SAVING DUE TO TREATMENT OF CROSSTIES WITH PRESERVATIVE AND USE OF TIEPLATES*

Species	Estimated life in years			Cost of ties			Annual charge in track			Annual saving of treated over untreated ties	
	A†	B	C	A‡	B	C	A	B	C	B	C
Black locust	20	..	..	§$0.60	.....	.....	$0.080	......	......	......	......
Redwood	12	..	..	0.53	.....	.....	0.104	......	......	......	......
Cedar	11	..	..	0.46	.....	.....	0.103	......	......	......	......
Cypress	10	..	..	0.41	.....	.....	0.104	......	......	......	......
White oaks	8	..	..	§0.60	.....	.....	0.155	......	......	......	......
Longleaf pine	7	20	..	§0.52	$0.89	.....	0.159	$0.103	......	$0.056	......
Chestnut	7	14	11	0.44	0.81	$0.61	0.145	0.122	$0.121	0.023	$0.024
Douglas fir	6	15	11	0.41	0.78	0.58	0.160	0.114	0.118	0.046	0.042
Spruce	6	14	11	0.49	0.86	0.66	0.175	0.127	0.127	0.048	0.048
Western pine	5	17	12	0.53	0.90	0.70	0.215	0.115	0.123	0.100	0.092
White pine	5	14	10	0.43	0.80	0.60	0.192	0.121	0.129	0.071	0.063
Lodgepole pine	5	16	11	0.46	0.83	0.63	0.199	0.113	0.124	0.086	0.075
Tamarack	5	15	11	0.41	0.78	0.58	0.187	0.114	0.118	0.073	0.069
Hemlock	5	15	11	0.33	0.70	0.50	0.169	0.106	0.108	0.063	0.061
Red oaks	4	20	12	§0.45	0.82	0.62	0.240	0.098	0.114	0.142	0.126
Beech	4	20	12	0.36	0.73	0.53	0.214	0.090	0.104	0.124	0.110
Maple	4	18	12	§0.45	0.82	0.62	0.240	0.104	0.114	0.136	0.126
Gum	4	16	11	0.52	0.89	0.69	0.338	0.119	0.131	0.219	0.207

*In each case a charge of 25 cents per tie for tieplates and 15 cents for placement has been added to the cost of the tie, and is included in the computed annual charge.

†A, untreated; B, treated with 10 lb. creosote per cubic foot; C, treated with ½ lb. zinc chloride per cubic foot.

‡In most cases, prices quoted were taken from report on "Crossties Purchased 1909," Bureau of Census.

§Prices quoted based on general observations.

Zinc chloride is injected into the timber in a water solution. When used in a wet climate it gradually leaches out and leaves the timber unprotected. In the dry and arid regions of the west this tendency is reduced, and excellent results have been obtained. Durability statistics are available, however, which show numerous cases, even in the wet regions of the east and south, where non-durable timbers treated with zinc chloride have lasted surprisingly well. It seems likely, therefore, that a serious shortage in the creosote supply will result in an increased use of zinc chloride.

OTHER PROCESSES

Empty-Cell Process.—A large amount of timber has been treated with creosote by the so-called empty-cell processes. Usually ties, bridge timbers, etc., are treated with 10 or 12 lb. of creosote per cu. ft. By the empty-cell process, however, this can be reduced to 5 or 7 lb. per cubic foot.

Mixtures of Creosote and Zinc Chloride.—In 1913 8,000,000 cu. ft. of timber were treated with a mixture of creosote and zinc chloride. In this case about 3 lb. of creosote are usually injected into each cubic foot of timber.

Water-Gas-Tar Creosote.—Further relief could also be had by utilizing creosote from water-gas-tar. A large amount of the water-gas-tar produced is now burned or thrown away. Much has been used for treating timber, usually in mixtures with coal-tar creosote. In composition it is very similar to the latter, but probably has less value in preventing decay. In experiments now being made by the Forest Products Laboratory untreated specimens of Southern pine were destroyed after nine months' exposure in the Gulf of Mexico. Specimens treated with water-gas-tar creosote and coal-tar creosote were practically sound, however, after two years, and are still in service. A pile was removed from Pensacola Bay, Florida, after 33 years of service and was in fairly good condition. An analysis of the oil in this pile showed that it was very similar in composition to much of the water-gas-tar creosote now being made. It seems possible, therefore, that piling for service in salt water could be treated with water-gas-tar creosote with excellent results. Certainly it would pay much better to use this product than to drive piling that has not been protected from the borers.

Creosote and Crude Oil Mixture.—One of the important qualities of a wood preservative is its toxic property. Experiments made at the Forest Products Laboratory indicate that the amount of creosote usually injected into wood is from 20 to 50 times greater than the amount actually required to prevent attack. In the case of zinc chloride the excess of zinc chloride over that required is under 60 per cent. Obviously, therefore, in comparison with zinc chloride, much more creosote is being introduced into timber than is required to prevent decay.

Petroleum oils tested appeared to be without toxic properties. They have been used to some extent in timber preservation, and with a certain degree of success, because of their property of excluding water from the timber, water being essential to the growth of fungi.

In view of the highly toxic properties of coal-tar creosote, why could this not be mixed with petroleum oils and still successfully preserve the timber? If the toxic limits of these preservatives would hold when applied to treated timber, 0.5 lb. of creosote per cubic foot of timber should preserve it better than a similar amount of zinc chloride. Why should we not, therefore, use a mixture of high-grade coal-tar creosote and crude oil, in proportions even as low as 10 per cent of the former, with excellent assurances of success?

Had all of the timber treated with creosote in the United States in 1913 been treated with a mixture of 10 per cent creosote and 90 per cent crude oil, the consumption of creosote would have been 10,837,000 gal. Since 41,700,000 gal. of domestic oil was used, there would have been a surplus of more than 30,000,000 gal. There are, of course, many situations where the use of such a mixture should not be considered—for example, in the treatment of piling for salt water, or the brush treatment of telephone poles. Should such a mixture be used for ties alone, however, this country could produce a large surplus of creosote oil.

Wood-Tar Creosote.—A further source of wood preservatives in this country may be found in the tars produced by the destructive distillation of wood. These are of two kinds, those from hardwoods and those from coniferous woods. At present these tars are a nuisance to the plants producing them and are either burned or thrown away. In the crude state they are absolutely unsuited for wood preservation. It is possible, however, to refine them and produce oils comparing very favorably with coal-tar creosote. One sample of creosote produced from hardwood tar was submitted to the Forest Products Laboratory that was more toxic than the coal-tar creosote mentioned above. Its specific gravity, range of distillation, specific viscosity, ease of penetration into wood and volatilization from wood were about the same as the creosote used for comparisons, the latter being a commercial product of good quality. It was much more corrosive in its action on flange steel than the coal-tar creosote, although this was but little greater than the corrosive action of a 3-per cent zinc-chloride solution. It would seem possible to refine this oil further and remove this objection.

Several concerns are now prepared to manufacture refined hardwood creosotes, and it seems likely that at least 10,000,000 gal. annually could be placed on the market. Since the present shortage probably amounts to less than 40,000,000 gal., the possibilities of relief from this source are considerable.

Sodium Fluoride.—One of the most promising of the new preservatives now being experimented with is sodium fluoride. This is a water soluble salt, and can be produced very cheaply in this country. At least one company is now prepared to produce it in large quantities. Its principal advantages compared with zinc chloride are its high toxic properties and its low solubility in water. Experiments at the Forest Products Laboratory indicate that it is from 2 to 5 times as toxic as zinc chloride and about the same as the coal-tar creosote. Zinc chloride is soluble in water in all proportions, while only 3½ to 4 per cent of sodium fluoride can be dissolved in water. Furthermore, it is only about 10 per cent as corrosive in its action on flange steel as zinc chloride.

Very good results have been obtained from the use of fluorides in Europe, especially in Austria, where several thousand telephone poles have been treated. The excellent prospects of the successful application of this preservative led the Forest Products Laboratory to institute service tests of timber treated with it. Several hundred mine ties treated with fluorides were installed in January, 1914, in the Birmingham district, and 300 ties treated with sodium fluoride are about to be installed in a test track on the Baltimore and Ohio Railroad.

CONCLUSIONS

It would seem possible for the United States to be wholly independent of Europe for its wood preservatives. With all of the possibilities mentioned above, it should not be necessary to shut down a single treating plant, nor to reduce the amount of timber now being treated because of the threatened creosote shortage. In conclusion, the seven possibilities of solving the question are:

1. Increased use of zinc chloride.
2. Use of the so-called empty-cell processes.
3. Use of mixtures of creosote and zinc chloride.
4. Use of water-gas-tar creosote.
5. Mixing creosote with crude oil.
6. Use of wood-tar creosote.
7. Use of sodium fluoride.

In the past it has been necessary to test out all new processes and preservatives thoroughly, under service conditions, before their adoption was considered. This requires at least 10 years. The necessity now arises, however, to utilize products whose value has been indicated chiefly by laboratory experiments, without waiting for service results. Why should we not, therefore, place greater reliance on the experimental results, and use our native products in this work? Would it not be much better to treat our timber with some of these products than to place it untreated, subject to rapid decay?

Many preservatives have been tested by the Forest Products Laboratory, and the results of these experiments will be published as a bulletin of the Department of Agriculture about Jan. 1, 1915. In the meantime this laboratory will be glad to place its information at the service of all who are interested and to render any assistance possible in the present situation. Letters should be addressed to the Director, Forest Products Laboratory, Madison, Wis.

Salt-Glazed Ware Pipe Specification

British Committee Representing Five Engineering Societies Specifies Hydraulic Test Under 20 Pounds Pressure

STANDARD specifications for salt-glazed ware pipe have just been issued by the British Engineering Standards Committee, which is supported by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute and the Institution of Electrical Engineers. The report was adopted by the sectional committee on vitrified ware pipes at its meeting on June 26 and by the main committee at its meeting on July 16, 1914. The chairman of the sectional committee is Sir Maurice Fitzmaurice.

TEST OF STRENGTH

Of special interest is the chapter dealing with tests. The pipes, when subjected to the hydraulic test at the manufacturer's works, must withstand an internal pressure on the barrels of 20 lb. per square inch without showing signs of injury or leakage. The pressure shall be applied at a rate not exceeding 10 lb. per square inch in 5 sec., and full pressure shall be maintained for at least 5 sec. Care shall be taken that all air is expelled before the test is commenced.

Should it be desired 5 per cent of the pipes ordered may be selected for testing under the hydraulic test at the manufacturers' works. If four-fifths of the pipes selected for testing comply with the hydraulic test the whole of the pipes represented (other than those which have failed) shall be accepted. If less than four-fifths of the pipes first selected comply with the test a further 5 per cent of the whole of the pipes represented shall be selected and so on until the total number of pipes which stand the test amounts to four-fifths of the total number of pipes tested, when the whole of the pipes represented (other than those which have failed) shall be accepted, or failing this, until the whole of the pipes have been tested, when only such as comply with the test shall be accepted. All pipes marked "Tested" shall have been subjected to and have withstood the hydraulic test. No other tests have been specified for the determination of the strength of the pipes.

Absorption Test

Pieces selected for absorption test shall be taken from the body of the pipe and not within 6 in. of the end. Each piece shall be of the whole thickness of the pipe and shall have two glazed surfaces, each having an area of not less than 8 or more than 20 in. super. The test pieces shall be dried at a temperature of not less than 150 deg. Celcius until no further loss of weight can be noted. They shall then be immersed in cold water and the temperature raised to boiling point (100 deg. Celcius). The water shall be maintained at that temperature for 1 hr., and after it has been allowed to cool, the test pieces shall be removed, carefully wiped with a dry cloth and then reweighed. The increase in weight of each piece by absorption shall not exceed 5 per cent for ¾ in. thickness and under, 6 per cent for over ¾ and up to 1 in., 8 per cent for over 1 and up to 1½ in. and 10 per cent for over 1½. One absorption test may be made from every 100 pipes ordered if so desired.

Replacing a 250-Foot Reinforced-Concrete Chimney

Masonry That Froze and Did Not Set Properly is Rejected After a Service of Seven and One-Half Years at Torresdale Filters, Philadelphia

A 250-FOOT reinforced-concrete stack built in connection with the pumping plant of the Torresdale filtration plant on the Delaware River at Philadelphia, is being torn down after it had been replaced by a brick chimney of slightly greater height, built adjacent to it. The reasons for the condemnation were that the stack had an inclination of about 2 ft. towards the pump house; that it swayed about 4 or 5 in. when subjected to heavy wind pressure; that it was cracked in several places, giving it an appearance of unsafeness; and that it would have wrecked the pumping plant had it blown down in that direction.

When the concrete chimney was built operations had to be rushed so as to get the filter plant ready on time. As soon as the contract had been let in December, 1906, the construction began and the stack was finished May 1, 1907. On days when concreting had taken place the average progress had been about 5 ft. Often the temperature was so low that, when the forms were removed, the concrete had not set, but hung together because it was frozen solid. On other days, especially when the lowest and highest portions were built, the temperature was high enough to permit the concrete to set properly. When the stack was finished the joints between the various stages in concreting were plainly visible from the ground. The concrete, which did not have any coarse aggregate, was mixed in the proportion of 1:3. The sand was taken from a natural deposit close by and had grains from ¼-in. size down.

Design of Chimney

On the plans and in the specifications it was stated that the stack was to have an offset 104 ft. above the top of foundation. Below this point the outside diameter was to be 12 ft. and the thickness of walls 10 in. with an interior lining 4 in. thick and an inside diameter of 9 ft. Between the lining and the outside wall a 4-in. air space was to be provided. At the offset for a distance of 9 ft. the walls were to be 18 in. thick and above the offset to the head of the chimney 6-in. walls were specified. An ample amount of reinforcement was also specified.

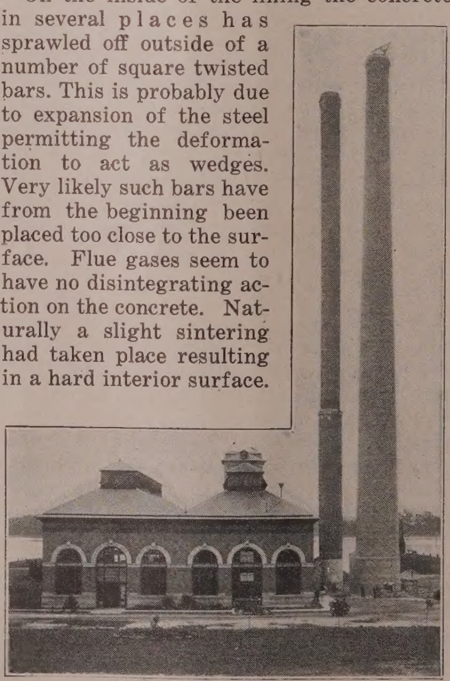
When the stack was razed it was found that these dimensions had been closely adhered to except for the walls, which were ¾ in. thicker on the north side (that toward the pump house) and ¾ in. thinner on the opposite side than specified. It was also found that the inclination had always been present and that when discovered during construction an attempt had been made to straighten the remaining part to be built. Although the construction joints were plainly visible it was found that the bond between courses was good. The concrete on the north side was found to be the hardest, while that on the south side was the softest. This fact is explained by the supposition that the latter side repeatedly froze and thawed due to the action of the sun, while the opposite side stayed frozen. No concrete work that had been frozen was of a first class quality, but it could not be classified as being directly dangerous. The top part, which had set properly, having been built during April, 1907, was of a very good quality and the progress in tearing it down was only about 3 ft. per day. When, however, the work done during March was reached the progress was increased to 8 ft. per day. In both cases the thickness of walls was 6 in. except for the head, which was 18 in. thick and 8 ft. high.

Demolishing the Old Chimney

For demolishing the structure sledge hammers are used to break the concrete in lumps of various sizes. The reinforcing rods are not cut but left sticking up until they can be loosened and thrown to the ground.

The reinforcement consisted of small round rods and square twisted bars of larger sizes. All steel is in good condition, and seems to have been well protected by the concrete.

On the inside of the lining the concrete in several places has sprawled off outside of a number of square twisted bars. This is probably due to expansion of the steel permitting the deformation to act as wedges. Very likely such bars have from the beginning been placed too close to the surface. Flue gases seem to have no disintegrating action on the concrete. Naturally a slight sintering had taken place resulting in a hard interior surface.



OLD AND NEW CHIMNEYS

As no rungs had been provided on the chimney the matter of climbing to the top of it to begin the work of wreckage was an interesting problem. Two 2 x 4-in. boards 14 ft. long with 1-in. transverse strips served as inclines and chiseled pockets or holes in the masonry served as supports. First one hole about 6 x 6 in. was cut near the bottom of the stack to serve as support for one board which leaned diagonally across the stack. Then the wrecker climbed this ladder, cut a hole in the wall slightly above the opposite end of the board to serve as support for the other piece, put that in place, climbed up on it, cut a new hole and then pulled up the lower piece and placed it in position. In the lower part of the chimney, where the lining was only 4 in., the holes went clear through, but higher up only pockets were necessary to serve as supports.

During the first day 175 ft. were climbed in this manner, the man in the evening descending a rope by which he was hoisted again the next morning. On the second day at noon he reached the top of the chimney. All told it had taken 14 hr. to climb the height of 250 ft. His helper, who was to have been present with a rope and block, failed to appear, so that the climber had to lie down on his planks on the top of the stack and wait until 5 p. m., when finally the rope arrived. A light rope, not sufficient to carry a man, had been brought up by the climber, and by it water and food were sent to him during his long wait. As soon as the rope had been hoisted and the tackle secured the man came down, none the worse for his experience.

The concrete chimney was designed and built by Alphons Custodis Chimney Construction Company; this firm also built the new brick stack and is tearing down the old one. The cost of the concrete stack was $7,500, while the new brick stack cost about $19,000.

Water Laboratory at Rensselaer

A NEW water analysis laboratory has been installed at Rensselaer Polytechnic Institute, Troy, N. Y., and Prof. W. P. Mason has supplied the following information regarding it. The laboratory accommodates sixty men at a time, each student being supplied with a desk of the usual laboratory type, having glass reagent shelves, drawers, cupboard, gas, water and electric current. Connected with this laboratory is a separate room, where ammonia distillations are carried on, thereby keeping the free and albuminoid ammonia determinations from possible laboratory fumes.

Another separate room is connected with the main water laboratory and in it all culture media are made which are used in the bacteriological examination of water. Lying between these rooms are the large incubators, each 8 x 8 x 8 ft. inside measurement. Their walls are carefully built of hollow tile with air spaces and paper lining. They are very heat proof. The doors are of ice-house pattern. The temperature in one of these incubators is maintained at 20 deg. C. and the other at 37 deg. C. by means of a cooling coil and an electric heater. A thermometer indicator on the outside shows the temperature within and a recording thermometer on the inside registers any accidental change in temperature.

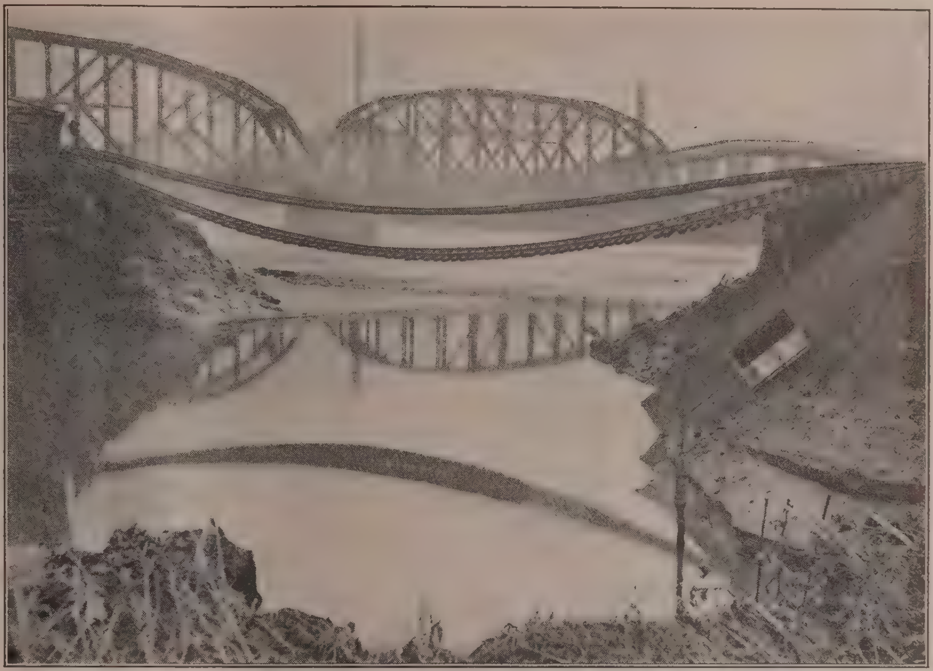
Sterilizers of hot air type as well as those using streaming steam and steam under pressure are installed, as is also one using the ultra-violet ray.

Kansas City Flooded

Heavy Rainfall Causes Overflow of Turkey Creek and Breaks in Levees at Three Points

By E. B. MURRAY
Consulting Engineer, Kansas City, Mo.

RAIN falling at the rate of 5 in. in an hour, as compared with a normal precipitation of 0.15 in., flooded Kansas City, Mo., Sept. 7. The storm commenced at about midnight Sunday, Sept. 6, assumed the intensity of a tropical downpour, and continued during Sept. 7. The deluge penetrated roofs which had never before leaked and the sewers backed up until basements were flooded. Some of the streets were 3 ft. under water. Seven inches of rain fell in 10 hr.



BREAK IN LEVEE SHOWING RAILROAD TRACK SUSPENDED OVER OPENING

RIVER STAGES

The Kaw River as well as the Missouri was at low stage; at noon, Sept. 7, the rise had been 10.5 ft. This was almost entirely at the lower end, especially below the mouth of Turkey Creek, which is approximately 11,000 ft. above the mouth of the Kaw. Turkey Creek was also at low stage, and it was this creek's overflowing its banks that caused 90 per cent of the damage.

The Santa Fé yards in Rosedale are from 2 to 6 ft. lower than the top of the levee which separates them from the Kaw River and there are innumerable drains, some of them 3 ft. in diameter, through the levee to take care of the surface water.

During the early morning of Sept. 7 this yard was covered with water to a depth of 2 or 3 ft., which was largely due to Turkey Creek's being out of its banks and spreading. It was not until the water in the yards was almost on a level with the top of the levee that breaks began, of which there were three.

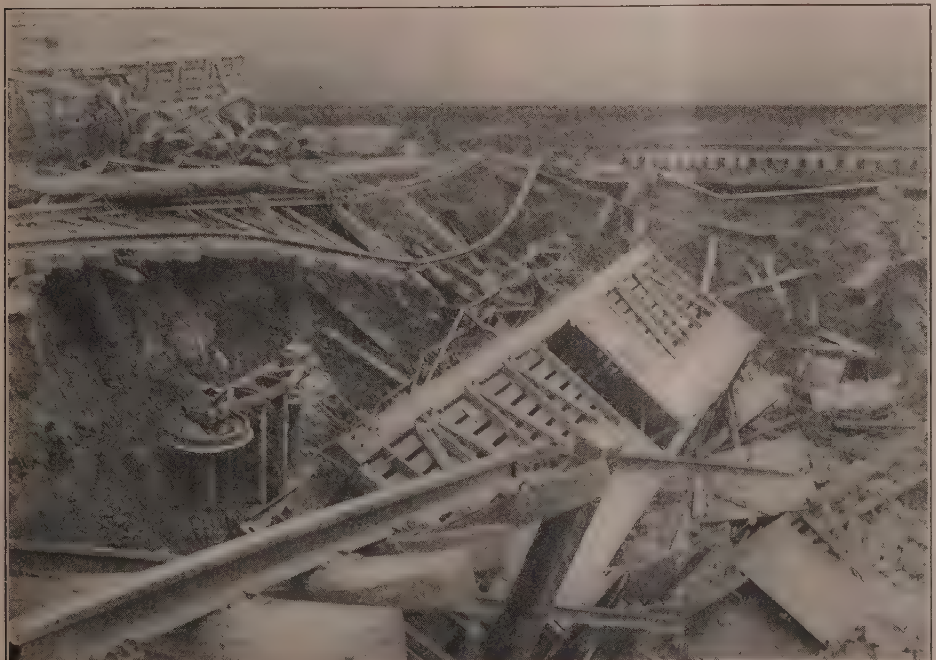
LEVEE BREAKS

The up-stream break occurred where there was a 3-ft. cast-iron pipe drain through the levee. The hole washed in the levee at this point was about 80 ft. wide and 35 ft. deep, and extended back into the Santa Fé yards for about 200 ft. There were several freight and cattle trains standing here at this time, as well as on the two tracks which are on the top of the levee, and the cars were either piled up in the hole or carried down stream.

The next break occurred at the Belt Line bridge where the bridge is 2½ ft. below the levee grade, and the water in finding this outlet very soon cut a deep hole about 60 ft. wide on each side of the track across the bridge. The third break occurred about 200 ft. below the bridge at a point where there was a 12-in. sewer through the levee. This hole was about 190 ft. wide and 35 ft. deep and extended back 400 ft. from the river, tapering to a width of 6 ft. The fact is evident that the water after leaving the Turkey Creek banks came down with considerable force and, in seeking an outlet, found a weak place in the back side of the levee where two sewers went through.

The St. Louis & San Francisco and the Missouri, Kansas & Texas had over 21 overturned passenger coaches in the coach yards, and the water was 5 ft. deep in the new terminal round-house. The Frisco lost 120 cars of grain. The Santa Fé lost one bridge. No trains from the southwest over the Santa Fé and Frisco got into the Union Station until late Monday night. A large force of men were employed all day Tuesday and Wednesday shoveling out the mud and silt that had been deposited in the first floors of the houses within the flooded district.

The natural course of Turkey Creek is very crooked, there being some right-angle turns in it, and it is crossed by half a dozen bridges, both steel and timber trestles, which are low. The water was no doubt out of its banks before these bridges began to dam up the natural channel, but the point remains that, had the natural channel been unobstructed, the amount of overflow would have been greatly lessened and the flood of shorter duration.



HOW RAILROAD TRACK WAS UNDERMINED AND ROLLING STOCK DAMAGED

Subsoil Investigations

SUBSOIL investigations by the U. S. Reclamation Service, both as to equipment and method, are noted in a paper on "Drainage Problems and Methods," presented early this year by J. L. Burkholder, assistant engineer to the Idaho Society of Engineers. Tools required vary with the nature of the materials found. Soil augers, made from common 2-in. augers by welding on a short length of 3-in. gas pipe and slightly altering the cutting edge, are the cheapest and most effective for clay subsoils. The handle consists of a 1-in. gas pipe cut in 4-ft. sections, and the drilling is done by two men, each having a 24-in. Stillson wrench, which is clamped on the handle and serves as a lever for propelling the drill. The wrenches are also used to lift the drill from the hole. The joints on the pipe serve as a convenient measuring device.

Borings may be made as deep as 30 ft. if the soil permits. If the subsoil is gravel the soil auger must be discarded for a Western automatic post-hole digger with an extension handle. A heavy digging bar is used in conjunction with this tool to loosen the material, and holes about 8 in. in diameter and 7 to 9 ft. deep may be sunk with it. If large boulders are encountered, open pits must be dug, a proceeding especially expensive where the water plane is high. In this case a diaphragm or tank pump must be carried along to keep the water down as the digging progresses. Test wells, as described above, will cost from $1 to $3.50 per hole, according to the conditions encountered.

RECORDS OF HOLES

The party required for the subsoil investigation consists of four laborers, a levelman, a rodman and a foreman. This party constitutes two boring gangs, the levelman and rodman laying out the location of the holes, and the foreman keeping the records. Each hole is flagged with a lath so that it may be found later by the party making the final location, and its location is recorded for plotting. The permanent record is kept by the levelman, who has previously recorded the elevation of a hub at each hole to which all measurements are referred. The information secured from these test wells is, first, the ground elevation; second, the elevation at which water was first struck; third, an accurate log of different soil strata, and fourth, the height to which the water rises in the hole. Later measurements are made of the water elevation in these pits to make certain that the maximum rise is recorded. Unless open wells are numerous, a few well points should be put in at selected points to observe further the elevation of the water plane, since the open test holes will generally become plugged in a short time.

VIEW OF VIADUCT, SHOWING MAIN SPAN OVER NORTHERN PACIFIC RAILWAY

Substructure of Lind Viaduct

Skeleton Reinforced-Concrete Abutments and Oblique Piers with Offset Footings Built in Keyed Horizontal Courses

LIND VIADUCT, on the Puget Sound extension of the Chicago, Milwaukee & St. Paul Railway, in Washington, has a reinforced-concrete substructure that includes unsymmetrical pedestals for tower columns, twin pier shafts connected by arches, and open-sided tall abutments. They differ materially from ordinary piers and retaining walls and were concreted in specified horizontal zones bonded together by keys and dowels.

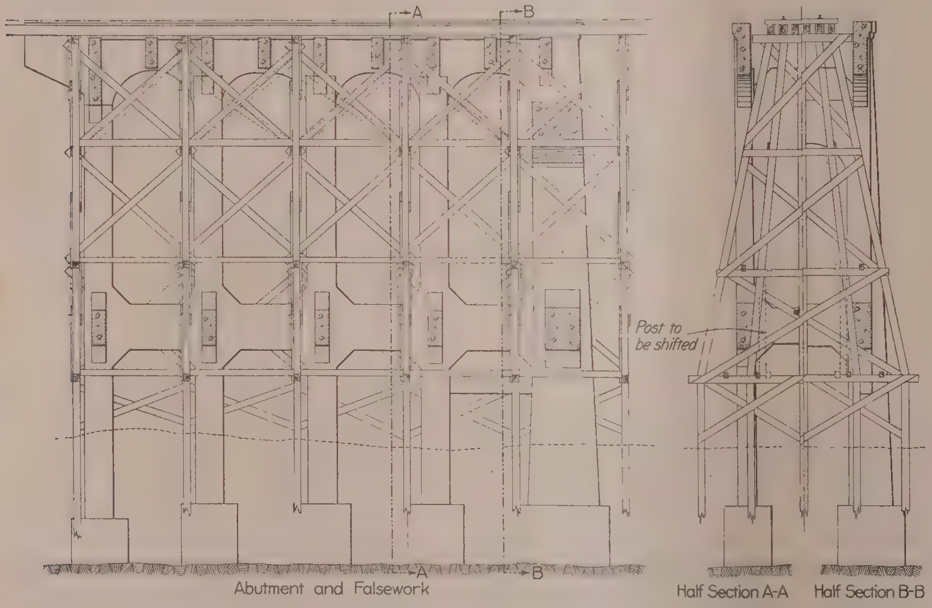
The viaduct is about 833 ft. long between abutments and 55 ft. high from the top of the lowest pedestal to the base of rail. It is a single-track concrete-floor structure, with plate-girder spans from 46½ to 93 ft. long, supported on steel towers, steel trestle bents, reinforced-concrete piers and tall reinforced-concrete abutments connecting the steel superstructure with the embankments at both ends of the bridge. It crosses the Lind Coulee, one highway, and the present Northern Pacific Railway track, making provision for three additional future tracks. The coulee and railroad crossing are at a sharp skew, while the highway crossing is at right angles. The track is on a light, varying grade, and the alignment is partly spiral, partly 2 deg. curve, and partly tangent.

PEDESTALS

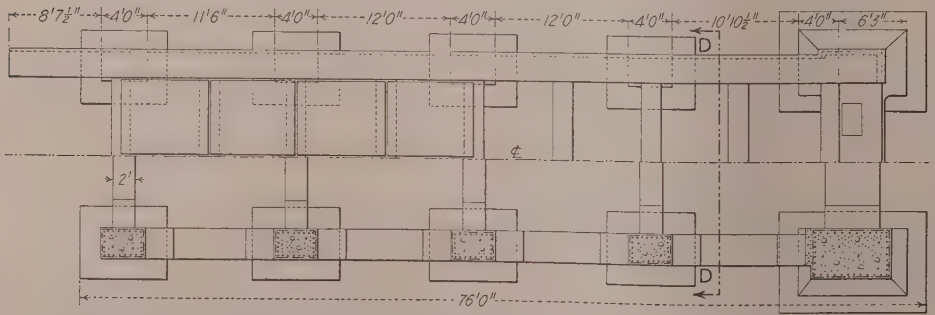
The pedestals for the steel towers and steel bents have separate concrete piers for each column and have a maximum height of 20 ft. The minimum height is 10 ft. and the minimum volume is 25 cu. yd. Part of them are founded on rock which receives a maximum load of 9 tons per square foot and part of them are on gravel which is loaded to 5 tons per square foot. These pressures take into account the eccentricity of load on foundation brought about by the action of horizontal forces. The average pressure due to vertical forces is much less.

The inner longitudinal faces are nearly vertical, while the outer longitudinal faces are battered 3½:12 (the tower columns are battered 2:12) and the transverse faces are battered 2:12, thus making an unsymmetrical pyramid. Two anchor bolts 10 ft. long engage a steel reaction plate embedded in the concrete 6 ft. 9½ in. below the surface. Clearance is left around the upper portion of the bolts to provide for their adjustment to register with the holes in the column bases. The upper faces of the pedestals are not horizontal, but are inclined normal to the center lines of the tower posts, which have square lower ends.

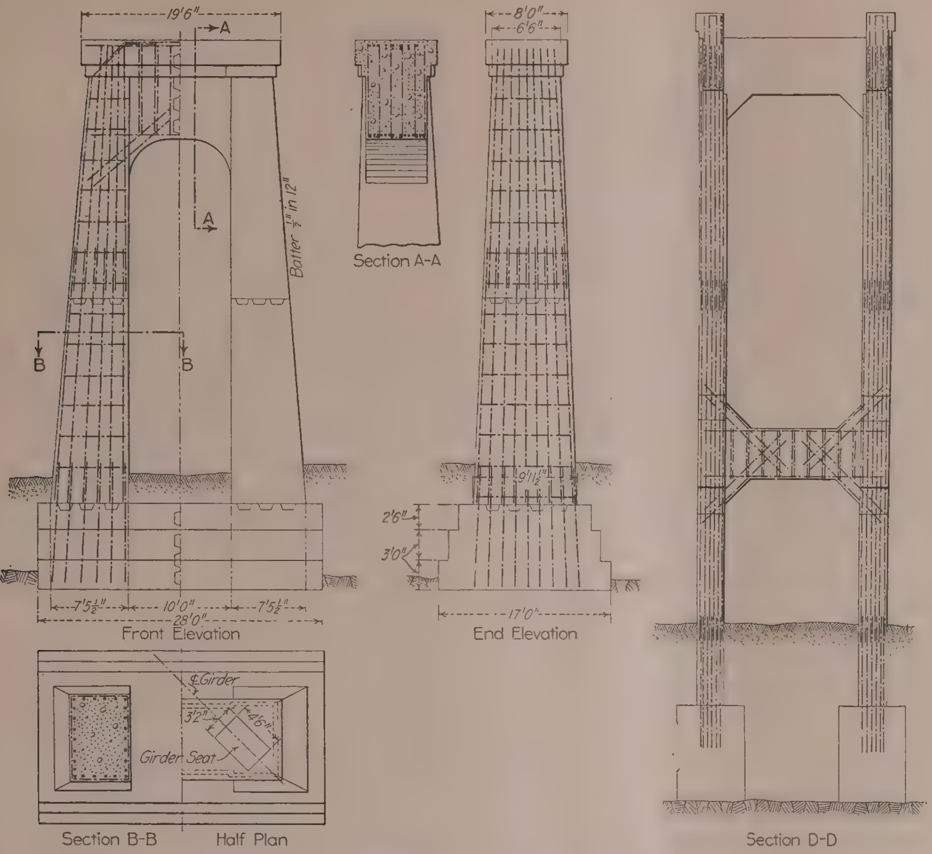
Where the rock surface is of such a nature that it is inadvisable to cut it to a single-level plane, the footing of the pedestal is offset. In such cases the batter of the face affected by the offsetting is increased so that the lower edge of the neat work comes vertically above its original position. When necessary the extension is effected by projecting the original footings to the rock line with a 6-in. horizontal offset for every 3 ft., as indicated in the footing diagrams. The footings do not



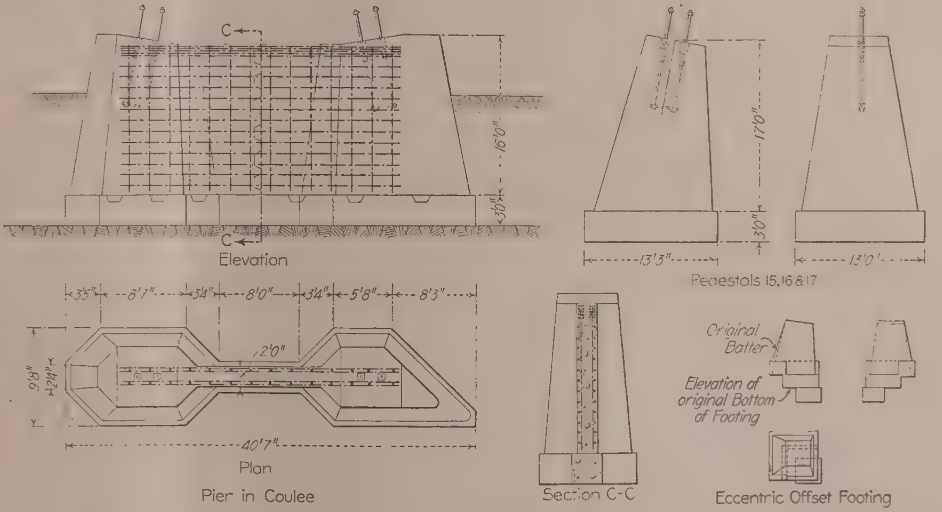
ELEVATIONS SHOWING CLEARANCE BETWEEN CONCRETE AND WOODEN STRUCTURES



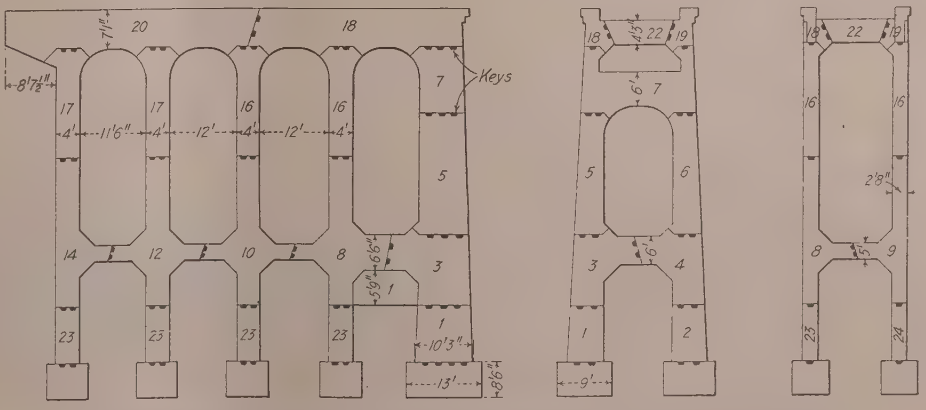
HALF PLAN AND HORIZONTAL SECTIONS THROUGH COLUMNS SHOWING STRUTS



DETAILS OF TRANSVERSE BENTS SHOWING ARRANGEMENT OF REINFORCEMENT



MAIN PIER WITH SKEW CUTWATER, UNSYMMETRICAL AND OFFSET PEDESTALS



DIAGRAMMATIC ELEVATIONS SHOWING CONSTRUCTION SECTIONS AND KEYS

project less than 6 in. nor more than 12 in. beyond the neat work.

The 93-ft. span has a clear height of nearly 45 ft. above the surface of the ground, and is supported on two reinforced-concrete piers. The piers are duplicates, except for slightly varying dimensions, and have extreme heights of 53½ and 56 ft. from the bottom of the footing to the top of the coping. The footings are carried down about 1 ft. below the surface of the rock and 10 ft. below the surface of the ground, and have embedded in them seventy-two 1-in. steel dowels 12 ft. long, which project 4 ft. above the upper surface to overlap and bond with reinforcement bars in each of the two pier shafts. The pier is symmetrical about the center lines and has two rectangular shafts 4 x 6 ft. 6 in. at the top. The shafts have vertical inner faces and are battered 1:12 and 1:24 on the other faces. Each is reinforced by vertical rods in two sections overlapping at the splice, and they are connected at the top by a concrete arch 6 ft. thick and 9 ft. 6 in. deep, which was cast with the pier shafts. The arch and coping are reinforced by horizontal bars, and there are inclined bars tangent to the intrados of the arch at the haunches.

The pier was concreted in six different sections, separated by horizontal and vertical construction joints as shown, each of which was bonded by concrete keys made by embedding 4-in. beveled blocks in the surface of the wet concrete and removing them as soon as the concrete was sufficiently set. The largest pier contains 365 yd. of concrete and 12,720 lb. of reinforcement steel.

PIER IN COULEE

Like the axes of the tall piers, the axis of the coulee pier is skewed with the bridge axis, but all of the other piers are square with it. The coulee pier has two pedestals which are similar to those for the floor columns, but which differ in cross-sections. They are united by a full-height vertical transverse reinforced-concrete diaphragm and are seated on a common footing. There is no reinforcement except that in the diaphragm, which consists of horizontal bars in the upper plane and horizontal and vertical bars in both vertical surfaces.

ABUTMENTS

The high abutments are really four and five-bent reinforced-concrete trestles, with columns passing down through the fill and below the surface of the ground to footings on sand and gravel at one end of the bridge and on rock at the other end. They allow the earthfill to pass around them with natural transverse and longitudinal slopes and nearly balanced thrusts on both sides, so that it is not necessary to provide the great lateral stability of retaining walls, which would be required if the embankment were limited by vertical planes.

One of the abutments is about 67 ft. and the other about 77 ft. high from the bottom of the footing to the base of rail. The ballasted track is carried on a solid concrete slab floor. The columns are reinforced by horizontal hoops and by vertical rods in several overlapping sections, the lower one projecting nearly through the concrete footing. The kneebraces and girders are also reinforced by main rods and stirrups.

The highest abutment contains 900 cu.

NORTHWEST ELEVATION OF EAST ABUTMENT

yd. of concrete and 103,000 lb. of reinforcement steel. A load of from 3½ to 4½ tons per square foot was allowed on its gravel foundation. The foundations of the other abutment were carried down to solid rock.

CONCRETING

Since the new structure was located on the same alignment as that of the timber trestle being replaced, it necessitated building the bridge under traffic. This was accomplished with very little interference with the old timber trestle. Only two posts in the second story of the timber trestle interfered with the longitudinal struts of the abutment, and these were shifted to a vertical position, giving the necessary clearance when the struts were cast.

The footings for the abutments were cast separately from the rest of the abutment masonry. The upper portion was cast in five stories of several sections each, with horizontal and vertical construction joints as indicated in the concreting diagram. The different sections were cast in the sequence of the numerals in the diagrams or in multiples of them, and the concrete was keyed at all joints with tennons formed by embedding 4-in. beveled blocks in the surface of the fresh concrete and removing them before the next section was concreted.

The viaduct was designed and constructed under the direction of the engineering department of the Chicago, Milwaukee & St. Paul Railway, of which C. F. Loweth is chief engineer and J. H. Prior engineer of design.

LOS ANGELES HARBOR WORK to the value of $847,786.95 was completed during the fiscal year ended June 30, 1914, according to the annual report of F. T. Woodman, head of the department of construction and maintenance. In the inner harbor 2920 ft. of creosoted-pile wharf have been completed, on which 1960 ft. of freight shed 100 ft. wide are being erected. In the outer harbor the reinforced-concrete wharf is finished. To date $2,752,630.79 has been spent, and $1,932,087.59 is yet available. The estimated value of contracts now in force and of work being done by force account is $1,211,970.

Operating Results of Harrisburg Filters for 1913

OPERATING results of the water filtration plant at Harrisburg, Pa., for the year 1913 are given in the recently published annual report of the Board of Water Commissioners, for whom James M. Caird served as consulting chemist and bacteriologist. The supply is taken from the Susquehanna River and passed through a settling basin and coagulating chamber and thence through mechanical filters to an uncovered reservoir. As the unfiltered water enters the settling basin calcium hypochlorite is added.

The turbidity ranged from 2 to 1600 parts per million; color, from 2 to 30 parts per million; alkalinity, from 2 to 109 parts per million, and bacteria, from 107 to 47,500 per cubic centimeter. All turbidity and color were removed in filtration and 99.94 per cent of the bacteria, leaving an average of but 3 bacteria in the filtered water for the entire year.

Four and nine-tenths parts of alkalinity were used by the application of 0.75 grains of sulphate of alumina, and sufficient CO_2 was always present in the water to decompose the 0.069 grains per gallon of hypochlorite that was applied to the raw water from the river. The hypochlorite, which is applied to the water in the intake well and sedimentation basin, reduced the bacteria 98.79 per cent in the treated water, an average of 62 bacteria per cubic centimeter when it goes on the filter.

The total number of gallons filtered was 3,160,891,600, of which 3,062,486,100 gal. were delivered to the pumping station, and 96,555,500 gal. or 3 per cent of the whole was used in washing filters.

CHEMICALS

The turbidity in the river averaged 55.7 parts per million, color 8.0 parts and the alkalinity 32.5 parts. The coagulant used an average of 4.9 parts of the alkalinity, leaving an average of 27.6 parts in the filtered water. Soda had to be used on 25 days during the year. The use of hypochlorite was continued all year and no trouble has developed from the high counts in the filtration.

The filters run an average of 17 hr. 32 min. between washings. In each wash averages of air for 4 min. and of water at a velocity equal to a vertical height of 0.9 ft. a minute for 5.6 min. were used. The time off for washing each filter averaged 18.6 min.

The operating expenses were $20,931.24, and were distributed as follows: Coagulant, $4,425.07; coal, $1,586.23; supplies, $1,715.32; materials and repairs, $2,687.97; oil and waste, $342.06; laboratory and chemist, $1,302.89, and salaries, $8,871.70. This makes the cost per million gallons $6.83; coagulant costing $1.45; coal, 52 cents; supplies, 56 cents; materials and repairs, 88 cents; oil and waste, 11 cents; laboratory and chemist, 42 cents, and salaries, $2.89.

Temporary Railway Bridge at Ellis, Ohio

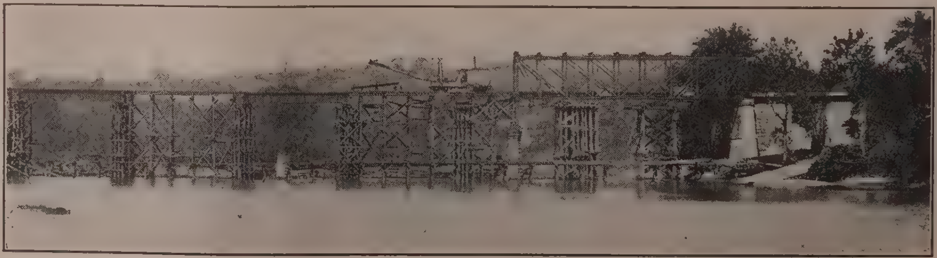
Trestle and Girder Spans for Temporary Service as Falsework and to Carry Traffic During Construction

THE reconstruction of the Pittsburgh, Cincinnati & St. Louis Railway bridge across the Muskingum River at Ellis, Ohio, is somewhat unusual on account of the fact that the work was done so as to maintain railroad traffic over a long structure at a considerable height above the river, support one end of an existing track span, provide clearance for the removal and rebuilding of the old piers, and furnish falsework for the erection of the new superstructure by means of a temporary structure.

Three of four 134-ft. through-truss spans were wrecked by flood in March, 1913, the superstructure falling to the bottom of the river alongside the piers. The fourth span remained in position in serviceable condition and is still in use, but the other spans, together with the approach at one end of the bridge, required to be rebuilt. Piles were driven and on them framed bents were erected by a derrick car to make falsework for the erection of the new superstructure and also to serve as a bridge carrying traffic until the permanent structure was erected. A low-level service track was installed on piles alongside the bridge and served for the distribution of materials and other construction purposes.

FALSEWORK CLEARANCE

As all three of the old river piers had to be rebuilt it was necessary that the falsework adjacent to them should have clearance for this purpose and several of the regular bents were therefore omitted at each pier and these spaces were spanned by plate girders supported on multiple bents of falsework braced to form towers between which the masonry construction was carried on. In order to support one end of the existing span and maintain it while the pier under it was replaced, a somewhat wider clearance was provided there and an 8-bent falsework tower with 48 vertical and inclined posts was built, and the third and fourth panel points from the ends of the trusses were wedged to bearing on it leaving the two end panels projecting as cantilevers beyond the tower. The tower also supported the plate girder spans carrying the traffic and the new steel work over the pier. The falsework and approach trestle were constructed by the Pittsburgh Construction Company.



DERRICK CAR ERECTING TEMPORARY RAILROAD BRIDGE AT ELLIS, OHIO

Plain Talk on Opportunities for Trade Expansion in South America

Financing Needed and Limitations Imposed by our Inability to Take Food Products in Exchange for Manufactures

By DAVID KINLEY, PH. D.

Director, Courses in Commerce, University of Illinois, U. S. Delegate to Fourth Pan-American Congress at Buenos Aires, 1910

IN our efforts to secure the South American trade opened to us by the war in Europe, we must keep clearly in mind certain conditions of success. We must be able to offer goods similar in kind and amount to those whose supply is cut off; we must be ready to take in exchange the products of our South American neighbors; and we must be able to finance the projects of the countries we wish to enter if we would make our entry into this trade permanent.

THE FIELD OPEN

In 1912 the United Kingdom, Germany and France together exported to the ten South American Republics an aggregate of $435,000,000, distributed as follows: United Kingdom, $244,972,000; Germany, $136,060,000; France, $53,853,000. In addition a considerable amount was taken from Belgium and Austria.

Of this trade, that from Germany, Belgium and Austria-Hungary is wholly cut off, while that from France and Great Britain will undoubtedly be considerably reduced. The figures serve, however, to show in a rough way the extent of the market opportunity.

But we cannot judge how much of this market we can capture without considering the nature of the articles traded in. Taking the markets of Argentina as an example, we find that in 1913 she imported $34,000,000 of food products; $89,000,000 of textiles and textile manufactures, of which $41,000,000 were cotton; $16,000,000 wool, and the rest other textiles. In addition she took from other countries $23,000,000 worth of oils, grease, etc., $14,000,000 of it being in kerosene, naphtha and similar products. In iron and steel and the manufactures of the same, the aggregate imports were $50,000,000; of railway cars, automobiles and railway carriages, $37,000,000; of building materials, $35,000,000; of earths, stones, glass, coal, etc., $36,000,000; and of electrical apparatus, $10,000,000. These are the largest items and most of them will appear as the largest items in the imports of the other South American countries. Evidently they are things which we can supply if we can increase our production sufficiently. Our present cotton crop is proving a source of financial embarrassment, yet if our mills were able to take it up and manufacture it into cloth we would be able to fill the South American gap in a very large measure. The fact that it is not being bought by our mills illustrates one of the limitations under which we work. That is, that to supply so large a market a tremendous increase of our industrial capital is necessary, and this cannot be suddenly made.

SOUTH AMERICAN PRODUCTS

Now to build up a trade we must not only be able to supply our South American neighbors with the things we manufacture, but we must be ready to take in exchange the things which they are accustomed to sell to Europe. We must be ready to take coffee from Brazil, Costa Rica and elsewhere, and cocoa from Ecuador. Bolivia is looking for another new market for her tin, of which 40,000 tons are said to be waiting for shipment now. Chile offers us minerals of various kinds, Peru has a variety of articles, but the most important of her present exports is nitrates. A good many of the exported articles are raw materials and food which we produce ourselves in sufficient quantity for our own consumption. We cannot step in and replace the demand of Germany, England and France for Argentine corn, wheat and meat. Hence it is clear that our new trade will be limited as much by the extent to which we are ready to buy their goods as by the extent to which we are able to supply our own.

We must remember, too, that a considerable portion of the goods exported from South America to Europe is to pay interest on European investments in that country, and is not in exchange for current products. Insofar as this is true, we cannot trade in those goods. To be sure, we have lost some of our market in Europe and what would normally go there may be diverted to South America in addition to new extra products that we can rapidly turn out. Nevertheless, when all limitations are allowed for, the market open to us in South America on account of the war is a tremendous one and very much larger than we shall be able to supply.

SOME CONDITIONS OF SUCCESS

As just remarked, a considerable proportion of South American exports represent interest on indebtedness. In other words, England, France and Germany have built up their great South American trade largely by financing South American enterprises. If we are to replace any or all of these countries in the future, we must furnish capital. This is particularly true in the west coast countries, whose mineral resources are awaiting a larger development than they have yet had. If we can loan South American enterprises sufficient capital we shall get the trade which these enterprises develop. For example, if a group of American financiers should advance $50,000,000 for railroad or mining enterprises on the west coast, they would not send gold to these countries. They would give the proper parties credit for the amount, and these parties would then purchase in this country the materials and other supplies necessary for the enterprise. They would pay for these by drafts on the credits which had been advanced to them. In due time, after their enterprises were under way and successful, they would pay the interest and the capital on their loan from the proceeds of their exports to this and other countries. It is obvious, then, that the financing of enterprises down there leads to an increase of exports from the country which does the financing. It is true that we can build up our trade to a considerable degree without financing enterprises, but we can never hope to get the large bulk of the business. For to trade with the people of an undeveloped country without financing them means simply to sell our products for theirs; but they have few products to sell unless they can get capital to make them. The more capital they can get the more they have to sell, and the more, therefore, they are able to buy. This process accounts for the great hold of the English and Germans in Argentina and Chile. There is a considerable field still open in these countries. But we would have an easier time in Peru, Ecuador and possibly Brazil.

There is too much talk of government initiative in this matter. We cannot build up trade by writing about it or talking about it, or by determining that "this country" must do business with some other country. Countries do not trade. Business firms and individuals trade. If, therefore, any manufacturer or group of manufacturers is in earnest about developing trade with South America he must proceed on his own initiative. He should send sensible, responsible agents at once to report upon the conditions under which business can be done. He should find the usual terms of credit, for the conditions and methods of doing business, particularly in granting credit, are not the same in all these countries in all lines of business. These agents should report exactly what articles the people have been accustomed to buy, and what they want in style, quantity, colors, prices, and other details. The manufacturer should then endeavor to meet the wishes of his prospective customers in all respects. All this implies what a recent manufacturer has called a "network of intelligent agencies."

FINANCIAL NEEDS

Moreover, it will be necessary to make reasonable conditions about payment. Consequently we must have better banking connections than we have had with South America. We must have banking agencies that will make it possible to establish credits in New York and Chicago to be drawn against by exporters and importers. These banking agencies can also be utilized for financing development. But they must be made to serve the people there and not be treated as simply an extension for our own profit by exploiting our customers. They must do banking business in South American ways and according to South American conditions.

SHIPPING

A good deal has been said about the need of shipping facilities. A careful study of the situation will show, I believe, that direct shipping connections have been lacking because we have not had the trade rather than because of the lack of vessels. In the past a considerable proportion of the vessel space from New York to Buenos Aires, for example, is said to have returned in ballast. There is less need for anxiety on the score of shipping than some people seem to think. Nevertheless, we should make an immediate and determined effort to get lines of ships within American control. We and the South Americans need our lines of steamers to do our business, if for no other reason than to avoid the preferential treatment of European exporters by European shipping.

CLEANING CATCHBASINS at Fitchburg, Mass., cost $5,557.91 for the year ended Nov. 30, 1913, according to the annual report of David A. Hartwell, superintendent. The cost of the work, covering 1766 single basin cleanings, was $2.87 per basin. The average quantity of material removed was 2.11 cu. yd. per basin and the cost per cubic yard was $1.52. Locations for disposal of the detritus make long hauls imperative, and half of the cost is for teaming.

Chicago & North Western Reduces Grades on Peoria Line

Quantities Involved and Equipment and Organization Used in Changing from a 1 to a 0.5-Per Cent Maximum

A GRADE-REDUCTION undertaking is rapidly being finished between Manlius and Radnor, Ill., on the Southern Illinois division of the Chicago & North Western Railway. The line was built with 1-per cent maximum grades, but with the extension of the road south from Peoria to Benlo traffic increased so rapidly that it became necessary to cut down the grades in order that the same number of trains could handle the increased tonnage. All grades greater than 0.5 per cent against northbound traffic were cut down to a maximum 0.5-per cent compensated grade. The work, which is divided into eleven districts, extends over a distance of 48 mi., about 18 mi. of which is included in the grade reduction, involving a removal of 700,000 cu. yd. of earth.

Grade Districts

The most extensive district is located at Camp Grove, where the summit of the grade in the cut was lowered 22 ft. and the maximum raise was 14 ft. on fill. This work extends over a district 4 mi. long and required the moving of 300,000 cu. yd. of earth. For this work a detour track was laid around the fill. It was necessary to make five runs through the cut with a 2½-yd. 80-ton Bucyrus shovel to take out the necessary material and at the same time care for the traffic. About 25 per cent of the work at Camp Grove was done under traffic, before the detour tracks could be laid. Except at Camp Grove, the work throughout the improvement was carried out entirely under traffic, which consisted of twenty trains per day, the average train being made up of 110 cars southbound and 40 cars northbound.

At Broadmoor, which is a water and coaling station, the change of grade extended for 3 mi. It was necessary to raise the yard tracks, coaling and water stations, depot and main-line track 7 ft., and the summit of the cut had to be lowered 13 ft. About 90,000 cu. yd. of excavation was necessary in this district.

Another important piece of grade work was encountered just north of Buda, where the grade was lowered 13 ft. at the summit. The cut soundings showed quicksand deposits. This was probably the most treacherous undertaking of any part of the work, but owing to the extreme dryness of the season it was possible to make the 120,000-yd. cut without any serious trouble with the quicksand. Of the remaining districts the heaviest jobs were located north of Radnor, where 80,000 cu. yd. of earth had to be moved; south of Akron, which took a month involving 65,000 cu. yd., and north of Speer, 40,000 cu. yd. being moved.

As a rule the existing bridges, which were of the pile-trestle type, were raised or lowered to fit the new grade. Alterations were made on six bridges and two new structures were put in.

Equipment and Organization

The contractors' equipment used on the entire work consisted of three outfits. Each outfit contained one 80-ton Bucyrus shovel, three standard-gage, 70-ton locomotives, and twenty-eight 12-yd. Western dump cars. Six Davenport and three Baldwin engines were used in all. About 150 men were attached to an outfit, this including track men and skilled laborers. In general each outfit averaged 70,000 cu. yd. per month, working in one shift of an average of eleven hours.

The supervision of the work was handled by F. C. Huffman, resident engineer, with headquarters at Camp Grove. Under him were three assistant engineers, E. S. Morris, B. M. Lockard and S. O. Kretsinger, who had charge of the Southern, Middle and Northern districts respectively. The contract was let May 15 to the Walsh Construction Company of Davenport, Iowa, and the shovels were at work May 21. The estimated cost ranges around $500,000 and Nov. 1 was stipulated as the date of completion. At present all grading with the exception of 30,000 cu. yd. at Camp Grove has been completed.

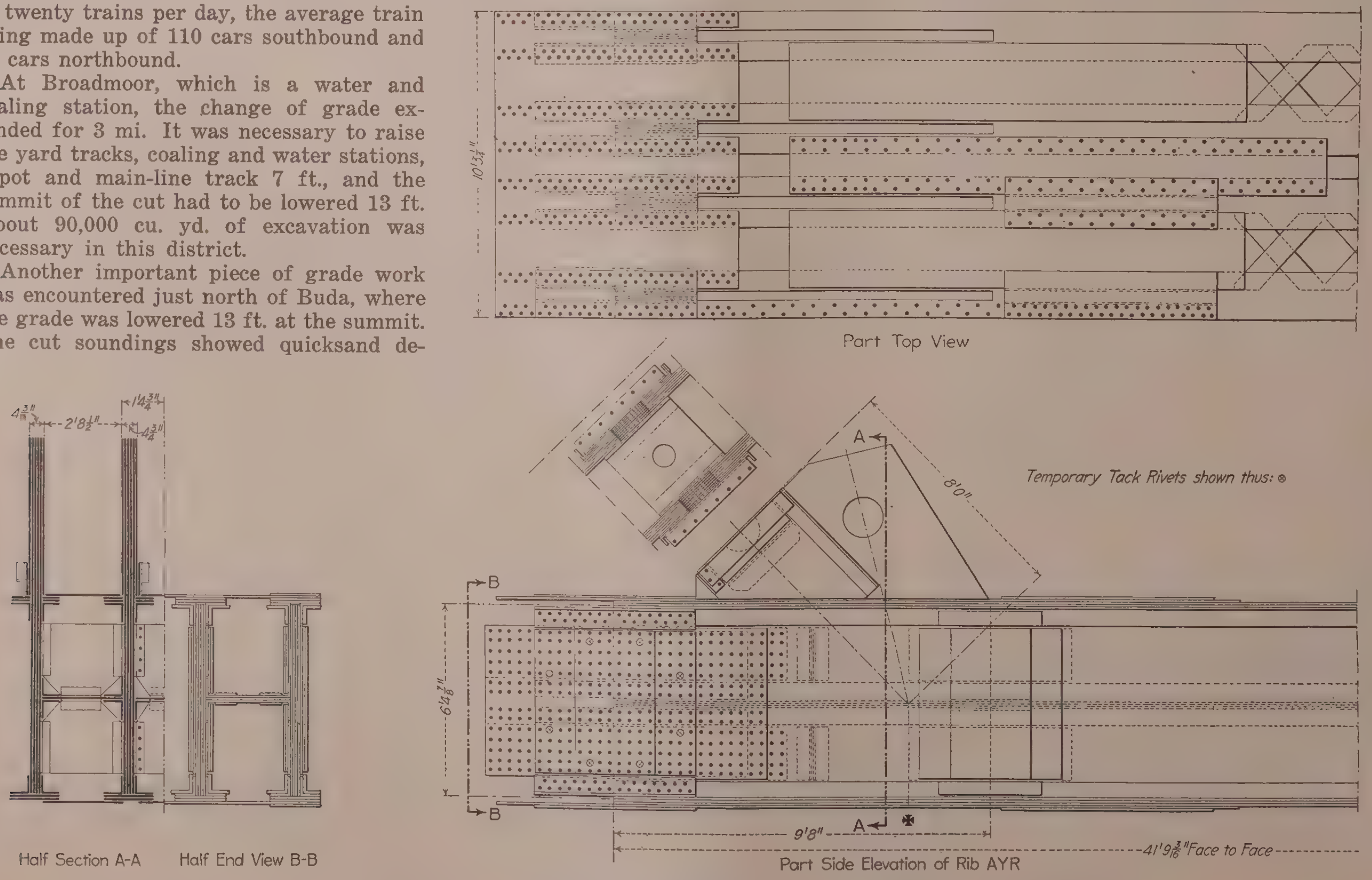
Quebec Bridge Anchor-Arm Bottom Chords

Quadruple-Web Compression Members 43 Feet Long, of 1900-Square Inch Cross-Section and a Maximum Weight of 423,000 Pounds

THE end bottom-chord sections between panel points 13 and 14 of the anchor arm for the Quebec Bridge are the heaviest members of the trusses, weighing 423,000 lb. These members are shipped and handled in two pieces, each of which weighs 187,000 lb., the remaining 49,000 lb. being made up of the connections and appurtenant parts. Thus the members far exceed the weight of the heaviest truss members usually fabricated, although they represent only one of four sections necessary to complete the member for the full panel length between main connections. This member is typical of the latest development in the arrangement of metal for very heavy compression members and embodies the conclusions determined by investigations for the largest recent bridge spans. It also presents special features of fabrication for the convenience of erecting and assembling in the field.

Maximum Section L13-L14

The lower chord L13-L14 adjacent to the main pier has a cross-sectional area of 1902 sq. in., being about 42 ft. 11 in. long and 10 ft. wide. This, as well as the other sections of the bottom chords, is symmetrical about both the vertical and horizontal axes, the depth of these chords diminishing regularly from 7 ft. at the main shoe to 4 ft. 1¾ in. at the end of the anchor arm. This longitudinal taper provides to some extent for the reduced area required as the strain diminishes from panel to panel approaching the anchor end without changing the trans-



Part Top View

Half Section A-A Half End View B-B

Part Side Elevation of Rib AYR

PART OF INTERMEDIATE CHORD SECTION L12-L13, WEIGHING 388,000 LB. COMPLETE verse width or the clearances for the connections of the web members.

The body of this chord section, like all the other lower chords, consists of four vertical webs connected by top and bottom flange latticing and tieplates, the two outside webs being connected by a horizontal diaphragm midway between the flanges. This diaphragm plate is connected to the web by two angles on each side, both plates and angles being figured in the cross-section of the member. The webs are also strengthened transversely by cross diaphragms about 15 ft. apart. The webs are built up of two ⅞-in. and two 1-in. plates stitch-riveted together with 1⅛-in. rivets, spaced according to the specification, which allows twelve times the thickness of the thinnest plate diagonally and sixteen times longitudinally, center to center of rivets.

WEB REINFORCEMENT AT RIBS

At all four ribs the webs are reinforced to a thickness of 6¾ in. to provide bearings for the 45-in. bushings of a 30-in. pin on the pedestal at the foot of the main vertical post. This end of the chord is machined at right angles to its axis at a distance of 1 33/64 in. from the center line of the pin to afford sufficient clearance from the face of the pedestal to take care of any distortion of the truss as a whole during erection.

At the opposite end the chord is finished square with its axis to give a full cross-sectional compression bearing on the chord piece L12-L13 and is connected to it by a field-riveted splice with web and flange splice plates as shown in the detail. To hold the numerous plates firmly together for shipment a few of the rivet holes are filled with countersunk shop-driven rivets through the four web plates and through each set of the four splice plates as indicated in the detail. The 8½ × 1-in. lattice bars take two rows of three rivets each in each end and four rivets at the intersection. The ends are beveled in two directions and the sheared surfaces are planed to exact length, any injured portions of the metal being removed.

PEDESTAL TO RECEIVE CHORD

The horizontal diaphragm rivets are ⅞ in. in diameter and a 2-in. drainage hole is provided adjacent to each of the vertical transverse diaphragms. The transverse diaphragms at L14 are provided with 10 x 16-in. manholes giving access to the four upper and lower divisions of the cross-section.

SECTION L12-L13

Lower chord L12-L13 is 41 ft. 9¾ in. long and weighs 388,000 lb. It has a cross-sectional area of 1896 sq. in. It has at each end a full section compression bearing, without pins, on the adjacent chord section, and is made of four webs exactly similar to those described for L13-L14. The depth of the ribs at one end is 6 ft. 4⅞ in. and at the other 6 ft. 8 in. The member is shipped in halves, each having a shipping weight of 179,000 lb., including the splice plates temporarily bolted to it at L12.

At all main panel points in all the bottom-chord sections the two outside web plates in each rib are cut and gusset plates of the same thickness inserted, the webs being fully spliced to the gusset. These four gusset plates project about 5 ft. above the top flange of the chord at L12 and are bored with a full hole for the pin connecting the vertical tension member and a half hole for the pin connecting the compression diagonal at this point.

Permeability Tests on Gravel Concrete

Proportions, Time of Mixing, Sequence of Placing Materials in Mixer and Curing Are the Vital Factors

TESTS to determine the permeability of concrete to water are being conducted at the University of Wisconsin. A partial report on these tests was read by Morton O. Withey, assistant professor of mechanics, before the Western Society of Engineers at the Sept. 14 meeting. The materials used for making test pieces were Universal Portland cement, sand of 104.5 to 112.2 lb. weight per cubic foot with 0.19 to 0.29 per cent absorption and gravel of 109.3 and 107.3 lb. per cubic foot and 0.63 and 1.4 per cent absorption respectively. Of the test pieces 88 were proportioned, by volume, 1:1½:3 and 67, 1:2:4; 98 were of 1:9 mixtures proportioned by weight. From these tests the following conclusions are drawn:

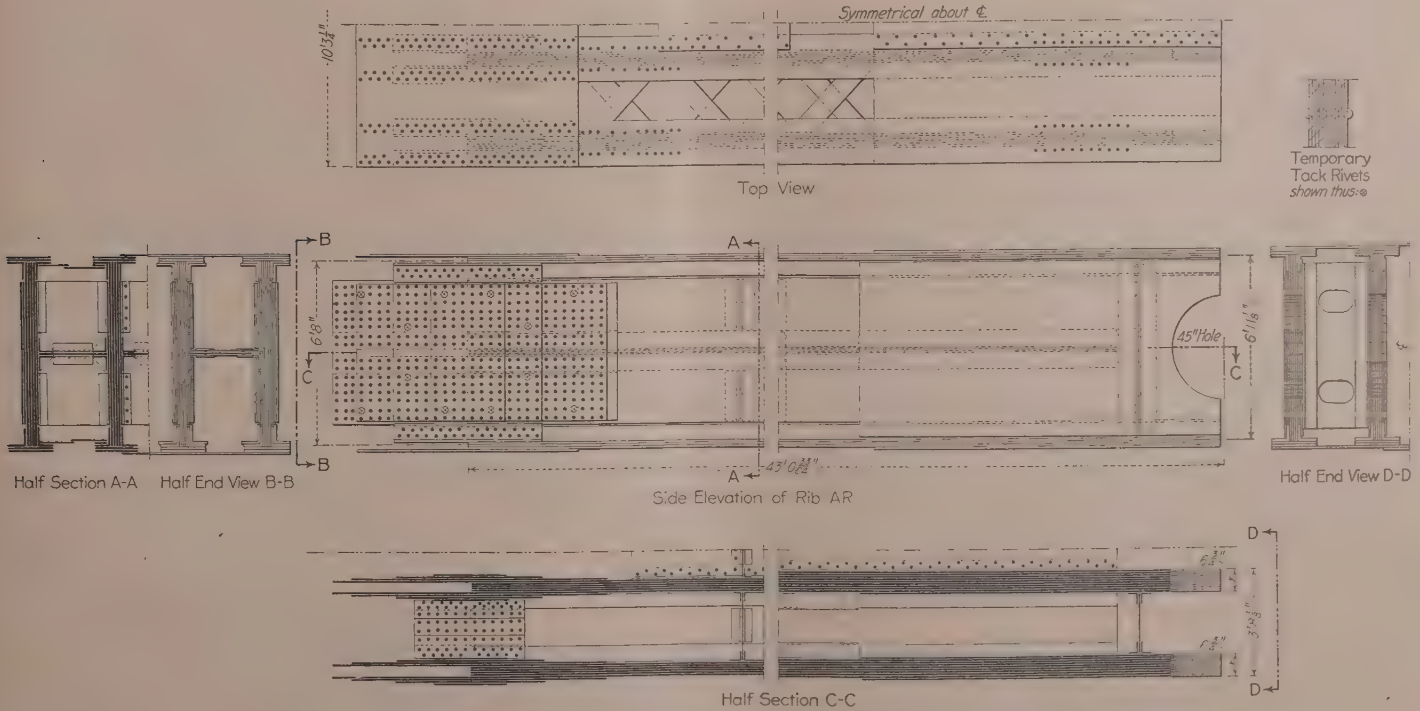
1. None of the concretes tested was absolutely watertight if we consider flow into the specimen as proof of permeability, but the majority of the mixes were so impervious that no visible evidence of flow appeared. For most purposes such mixes can be considered watertight.

2. The visibility of dampness on the bottom of the specimens increased with the humidity of the air and the non-homogeneity of the concrete. The minimum rate of flow for which leakage was indicated was 0.00011 gal. per square foot per hour.

3. In tests of nearly all of the properly made mixes of 1:7 proportions, or richer, the rate of flow for a 50-hour period was less than 0.0001 gal. per square foot per hour under a pressure of 40 lb. per square inch.

4. Through increasing the fineness of the cement a reduction in the rate of flow and a considerable increase in the strength of a 1:9 mix were secured.

5. By grading the sand and gravel in accordance with Fuller's curve it was possible to obtain practically watertight concrete of 1:9 proportions under pressures less than



MAXIMUM END SECTION L13-L14 OF LOWER CHORD WHICH WEIGHS 423,000 LB. COMPLETE

40 lb. To secure such results, however, requires great care and careful supervision in mixing, in determining the proper consistency, in placing, and in curing the concrete.

6. In the proportioning of such materials as these, volumetric analysis coupled with a determination of the density and air voids yields very valuable information concerning the best proportions of sand and gravel for a given proportion of cement. If proportions must be selected arbitrarily a 1:1½:3 mix is very impervious. It should be remembered, however, that the volume changes in rich mixes due to alternate wetting and drying are much greater than for lean mixtures. Consequently due attention must be given to the provision of expansion joints and reinforcement in structures made of them.

PROPER AMOUNT OF WATER

7. The use of the proper amount of water necessary to produce a medium or mushy consistency is one of the most important conditions in securing impervious concrete, especially when lean mixtures are used. Dry mixtures cannot be sufficiently compacted in the molds and are more difficult to cure properly than the mushy mixtures. Although the use of a wet consistency does not materially affect the imperviousness of very rich mixes, such as 1:1½:3, it greatly increases the flow through a lean mix.

8. For lean mixes made from damp sand it seems advisable to mix longer than is now common practice. These tests would indicate that for a mixer running at 30 r.p.m., a period of 1½ to 2 min. is required to secure thorough mixing of a 1:9 concrete. For a rich 1:1½:3 mix a 1 min. period appears to be sufficient. The method of mixing in which water is first admitted to the mixer is to be condemned. A preliminary period of dry mixing lasting from 15 to 30 sec. seems desirable.

9. No stage or process in the making of impervious concrete is of more importance than curing. The results of these tests clearly demonstrate that premature drying destroys the imperviousness of 1:9 mixes, seriously impairs that of the 1:2:4 mixes and somewhat diminishes that of the 1:1½:3 mixes. For thin sections, not over 6 or 8 in. thick, the curing conditions should be such that a lean concrete will be kept damp for a period of 1 month and a rich concrete for at least 2 weeks. Even after 1 month of proper curing, complete desiccation of a lean mix composed of these materials produces an increase in permeability, but the effect on a rich mix is not marked.

10. In these tests the imperviousness of the concrete increased rapidly with the age of the specimens for the first month; thereafter the change was not marked.

11. From the tests thus far made it seems probable that the permeability of lean concrete in a direction normal to the pouring is greater than in the direction of pouring.

HEAVY RAINFALL occurred in the Canal Zone near Gatun on the afternoon of Aug. 12. The maximum fall for 1 hr., 3.45 p. m. to 4.45 p. m., at Gatun, amounted to 4.72 in. This hourly record has been exceeded but twice on the Isthmus since automatic records have been kept, namely, 5.86 in. in 1 hr. at Balboa on June 2, 1906, and 4.90 in. at Colon on Oct. 8, 1908. The heaviest fall on Aug. 12 occurred at Agua Clara reservoir, amounting to 7 in. in a little less than two hours.

How to Insure Minimum Cost and Prompt Delivery of Steel Reinforcing Bars

Reasons Why Odd Sizes, Short Lengths, Special Specifications and Changes in Orders are Uneconomical—Part I

By A. D. MELLOR
Contracting Engineer, Concrete Steel Company, New York

THERE are several points in connection with the problem of purchasing steel reinforcing bars which, if borne in mind by the designer and buyer, will save considerable time and money in the execution of reinforced-concrete structures. They are so simple and appear so self-evident when one has a clear understanding of the problem that the writer would hesitate to present them to the readers of the Engineering Record were it not for the fact that so many buyers ask for prices on schedules which show clearly that these simple points are understood by but few.

The secret of the successful solution of the problem of purchasing bars is the simplification and standardization which has been successful with all sorts of problems. An ideal schedule of steel would call for bars of but one size and one length, rolled from steel of standard quality. Such an order would be shipped by the mill in the shortest possible time and at the minimum price. Of course, for most jobs, this is but a proverbially elusive ideal; but the nearer we can come to it the lower will be the cost and the shorter the time for completion. These points are of vital interest to all concerned—owner, designer and constructor.

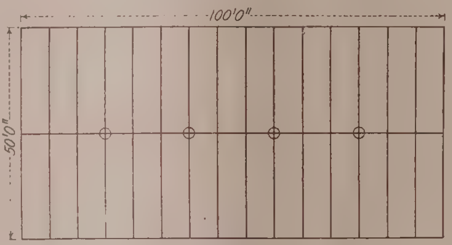


DIAGRAM OF TYPICAL FACTORY

SIZES

Usually the greatest stumbling block is size. Troubles and costs increase with the number of sizes of bars called for in the schedule. Indeed, to the poor contractor who is obliged to execute designs which call for many sizes, varying by sixteenths of an inch it often seems as if the troubles and costs increase directly as the second or third power of the number of sizes, for there is no end of trouble from the time the order is booked with the mill until the rods are in the work.

Let us look at the effect of size extras on price. All prices for bars, for whatever purpose, are figured in the same way. There is what is known as the base price for ¾-in. bars and larger, to which is added the size extras shown in Table 1 to determine the prices of smaller sizes. These extras are standard with all the mills and are the same for either round or square bars.

TABLE 1—SIZE EXTRAS FOR ROUNDS AND SQUARES IN CENTS PER 100 POUNDS

¾-inch and larger	Base
⅝ to 11/16-inch	5 cents extra
½ to 9/16-inch	10 cents extra
7/16-inch	20 cents extra
⅜-inch	25 cents extra
5/16-inch	35 cents extra
¼-inch	50 cents extra

To bring out the effect of these extras, let us assume that we are in the market for 800 tons of reinforcing bars, and are considering a design calling for all the sixteenth-inch sizes from ¼ to ¾ in. inclusive. This we will call Case 1. In comparison with it, we will consider Case 2, calling for the same tonnage but scheduling the larger bars, which take smaller size-extras.

TABLE 2—EFFECT OF SIZE-EXTRAS ON PRICE FOR TWO CASES

Size, In.	Size-Extras per 100 lb.	Case 1 Weight in 100 lb.	Case 1 Cost of Size-Extras	Case 2 Weight in 100 lb.	Case 2 Cost of Size-Extras
¼	$0.50	2000	$1000	2000	$1000
5/16	0.35	2000	700	....	....
⅜	0.25	2000	500	4000	1000
7/16	0.20	2000	400	....	....
½	0.10	2000	200	4000	400
9/16	0.10	2000	200	....	....
⅝	0.05	2000	100	4000	200
11/16	0.05	2000	100	....	....
¾	None	....	....	2000	....
		16.000 = 800 tons	$3200	16,000 = 800 tons	$2600

($3200 — $2600) = $600 = saving in size-extras by avoiding odd sixteenths.
800 tons at $29.00 = $23,200, a saving of 2.59 per cent.

From Table 2 it is clear that we can cut down the cost of the steel 2.59 per cent by so changing our design as to avoid ordering bars of odd sixteenth sizes.

EXCESS STEEL NEGLIGIBLE

But the designer points out the fact that we have worked on the assumption that the tonnage would be the same in either case. This he holds is not in accordance with the facts, for if his calculations show that a bar of an odd sixteenth is required, he would increase the total weight if he substituted a larger size, and the cost of this additional amount of steel would more than offset the possible saving in extras. But the weak point in this argument is the assumption that his calculations are inflexible. When it is borne in mind that the relative amounts of steel and concrete permit of considerable adjustment, and that his assumptions as to loadings and other factors will not be realized exactly when the structure is in use, it is clear that he should not be too theoretical.

For the sake of argument, we will grant that after he has studied carefully the possible adjustments of the relative amounts of steel and concrete he still finds that the odd sizes are called for by his calculations. To make clear the point to be made, let us again take an example. Assume that we have a factory of the beam and girder type, 100 x 50 ft., five stories high, without basement, divided into bays as shown in the diagram.

Before going further, it will be necessary to explain Table 3. This table is used by one of the largest organizations of engineers and contractors specializing in reinforced concrete work in this country. It has been designed for convenience in selecting the combinations of standard bars which will furnish a desired total tensile value. By reading across the first five columns from the left we get the combination of bars which will give the values in the last four columns. (It will be noted that these are indicated in values of 1000 lb.). If we are using an allowable working stress of 20,000 lb. per square inch, as is frequently done when deformed bars are used, we will find the total tensile values of the various combinations of square bars in the first column under "Square-Bar Values"; if we are working with 16,000 lb., the total will be found in the second column. The corresponding values for round bars will be found in the two columns under "Round-Bar Values."

To illustrate: Read across the fourth line from the top. Two bars 1 in. square at 20,000 lb. per square inch, will, of course, furnish a total tensile value of 40,000 lb.; or, on the 16,000-lb. basis, they will furnish a value of 32,000 lb. The last two columns show corresponding values of 31,400 and 25,100 lb. for round bars 1 in. in diameter.

TABLE 3—TENSILE VALUE OF COMBINATIONS OF DIFFERENT SIZES OF BARS FOR TWO UNIT STRESS VALUES

Combination	Steel Sizes, In. 1¼	1⅛	1	⅞	¾	Square-Bar Values At 20,000	At 16,000	Round-Bar Values At 20,000	At 16,000
1	..	..	..	..	2	22.5	18.0	17.7	14.1
2	..	..	..	2	..	30.6	24.5	24.1	19.2
3	..	..	1	1	..	35.3	28.3	27.7	22.1
4	..	..	2	..	..	40.0	32.0	31.4	25.1
5	..	1	..	1	..	40.6	32.5	31.9	25.5
6	..	..	1	..	2	42.5	34.0	33.4	26.7
7	..	1	1	..	..	45.3	36.3	35.6	28.5
8	..	..	..	3	..	45.9	36.8	36.1	28.9
9	..	1	..	..	2	47.8	38.3	37.6	30.0
10	..	2	..	..	..	50.6	40.5	39.8	31.8
11	..	..	1	2	..	50.6	40.5	39.8	31.8
12	..	1	..	2	..	55.9	44.8	43.9	35.1
13	..	..	3	..	..	60.0	48.0	47.1	37.7
14	..	..	..	4	..	61.2	49.0	48.1	38.5
15	1	..	..	2	..	61.9	49.5	48.6	38.9
16	..	..	..	2	3	64.4	51.5	50.6	40.5
17	..	1	2	..	..	65.3	52.3	51.3	41.0
18	..	..	2	2	..	70.6	56.5	55.5	44.4
19	..	..	2	..	3	73.8	59.0	57.9	46.3
20	..	3	..	..	..	75.9	60.8	59.6	47.7
21	..	..	..	5	..	76.6	61.3	60.1	48.1
22	..	..	4	..	..	80.0	64.0	62.8	50.3
23	..	2	..	2	..	81.3	65.0	63.8	51.1
24	..	..	3	..	2	82.5	66.0	64.8	51.8
25	..	2	..	..	3	84.4	67.5	66.3	53.0
26	..	..	2	3	..	85.9	68.8	67.5	54.0
27	..	2	2	..	..	90.6	72.5	71.2	56.9
28	..	..	3	2	..	90.6	72.5	71.2	56.9
29	3	..	..	..	..	93.8	75.0	73.6	58.9
30	..	..	4	1	..	95.3	76.3	74.9	59.9
31	..	2	..	3	..	96.6	77.3	75.8	60.7
32	..	..	5	..	..	100.0	80.0	78.5	62.8
33	..	4	..	..	..	101.3	81.0	79.5	63.6
34	..	3	..	2	..	106.6	85.3	83.7	67.0
35	2	..	..	3	..	108.4	86.8	85.2	68.1
36	..	2	3	..	..	110.6	88.5	86.9	69.5
37	..	3	2	..	..	115.9	92.8	91.1	72.9
38	..	4	..	1	..	116.6	93.3	91.6	73.2
39	..	..	6	..	..	120.0	96.0	94.3	75.4
40	..	4	1	..	..	121.3	97.0	95.2	76.2
41	2	..	3	..	..	122.5	98.0	96.2	77.0
42	..	1	5	..	..	125.3	100.3	98.4	78.7
43	..	5	..	..	..	126.6	101.3	99.4	79.5
44	..	2	4	..	..	130.6	104.5	102.6	82.1
45	..	3	3	..	..	135.9	108.8	106.8	85.4
46	..	..	7	..	..	140.0	112.0	110.0	88.0
47	..	4	2	..	..	141.3	113.0	110.9	88.8
48	..	1	6	..	..	145.3	116.3	114.1	91.3
49	..	5	1	..	..	146.6	117.3	115.1	92.1
50	..	2	5	..	..	150.6	120.5	118.3	94.6
51	..	6	..	..	..	151.8	121.5	119.3	95.4
52	..	3	4	..	..	155.9	124.8	122.5	98.0
53	5	..	..	..	..	156.3	125.0	122.7	98.2
54	..	4	3	..	..	161.3	129.0	126.6	101.3
55	..	5	2	..	..	166.6	133.3	130.8	104.7
56	..	6	..	..	..	171.9	137.5	135.0	108.0
57	3	..	4	..	..	173.8	139.0	136.5	109.2
58	..	7	..	..	..	177.2	141.7	139.2	111.3

WEIGHT OF EXCESS STEEL

Now, let us take one of the weakest points in this table and see how much we would diverge from the theoretical if we used it in one of the most unfavorable instances, and how much such divergence would cost us. Entering the table at Combination 11, we find that one 1-in. and two ⅞-in. square bars at 20,000 lb. per square inch give us a total tensile value of 50,600 lb., and that the next combination, No. 12, gives us a value of 55,900, or a difference of 5300 lb. This is one of the largest differences to be found in the table. Adding half of this difference to the above value for Combination 11, we have 53,250 lb.

Now let us assume that this was the tensile value which the designer's calculations showed as necessary for each of the beams in the diagram shown. A combination of one 1-in. and two 15/16-in. square bars at 20,000 would give us 55,200 lb., and three 15/16-in. square bars would give 52,700 lb. Suppose we use Combination 12, which gives 55,900 lb. We would then be furnishing an excess tensile value of 2650 lb. This value divided by 20,000 lb. gives us 0.1325, or the number of excess square inches of steel per lineal inch of beam. This is equivalent to 0.45 lb. per lineal foot of beam. Assuming the total length of beams per floor as 800 ft., we have an excess weight of steel of 360 lb. (This length of 800 ft. is practically the length of the steel figured unbent. The bends would make the steel longer than the clear spans of the beams, but this difference would be balanced by the fact that the clear spans are less than half the out-to-out width of the building.) Figuring this steel in place at $2.50 per 100 lb., we have an excess cost of $9 for all the beams. The excess on the girders would probably be about $4.50, making a total of $13.50. Since the spacing of slab reinforcement can readily be adjusted to avoid odd sizes of bars, this is the total excess cost per floor. Therefore, if for the factory under consideration we use the standard reinforcing bars recommended in this table, the total cost of the weight of steel in excess of that which would be required if we held closely to our theory is $67.50. This is less than ¼ of 1 per cent of the cost of the building and is so small an amount as to be negligible.

A designer who has made a layout with the square bar can cut down the cost for size-extras on the steel by substituting the next larger size in rounds in each case. If this causes an increase in area it can be compensated by changing the spacing or the combination of the bars. The larger round bar would take a smaller size-extra than the square for which it was substituted. (See Table 1.)

DELIVERIES

But price is not the only determining factor in the problem of placing a steel order. Speed of delivery is often of more importance than price. From the day that the owner pays out the first money in connection with the new structure until he makes use of it he is carrying an increasing charge for interest on the money invested, for which he gets nothing in return. Every day of delay means increased losses. The architect, or engineer, is efficient according as he decreases or increases this loss. From the contractor's point of view, the structure cannot be completed in too short a time, for the sooner final payment is made the sooner he gets his percentage of profit and puts his plant to work earning another profit.

When standard bars are used in place of odd sixteenths, as shown in Table 2, five in place of eight sizes are required. This means a simpler schedule, which is easier for the mills to handle. The more convenient the schedule is made for the mills, the quicker and more certain will be the shipments.

Excepting for very large orders, it usually takes a number of schedules to make tonnage enough for a mill-rolling of any one size. To illustrate: Suppose that you place an order for 40 tons, made up of 8 tons each of ¾, ⅝, ½, ⅜ and ¼-in. squares. Eight tons of ¾-in. is not enough for a rolling, and unless enough other orders calling for that size are on hand to make a rolling the ¾-in. bars will not be rolled immediately. It might happen that on the day the order came up for attention the mills were rolling ⅝ and ½ in. In that event these sizes would be rolled but the shipment of the order would be deferred until such time as combinations of schedules could be made up that contained the unrolled sizes. Later the ¾ and ⅜-in. might be rolled, still leaving the ¼-in. unfilled. Finally the ¼-in. is rolled and the order is shipped.

ODD SIZES

Now it is clear that if all the odd sixteenth sizes between ¾ and ¼-in. had been included in the order, the probability of not being able to get rollings promptly would have been increased by the additional number of sizes called for. Of course, if the mills were not busy, they might roll the odd sixteenths, with the regular sizes, by opening or closing the rolls; but when the mills are busy there would be little chance for this. They could not bother with such irregularities, for a greater daily tonnage could be gotten out by working on easier orders. It could not be expected that the mills would do otherwise, for if they did not get the easiest work out of the way first all shipments would be slow. Therefore, it is clear that the fewer the number of sizes on a schedule the quicker the shipment will be made, because there is less probability of delay due to waiting for schedules enough to make a rolling.

Schedules calling for less than a ton of any size cost more per hundred pounds because the following quantity extras apply:

(1) 15 cents per 100 lb. for quantities less than 2000 lb., but not less than 1000 lb.

(2) 35 cents per 100 lb. for quantities less than 1000 lb.

(To be concluded)

Floating a Concrete Reservoir Onto Its Foundations

Peculiar Local Conditions Permit Adoption of Method of Construction Utilizing Difference in Level Between River and Ground Water

A REINFORCED - CONCRETE Basin was built last year to retain storm water from a suburb until the sewers through the city of Strassburg, Germany, could carry away the runoff from the city. The site for the basin was a low place where the ground water was only 5 ft. below the surface, while the structure was 10 ft. deep. To put down sheet piling and excavate in the open was impossible as the leakage through the gravelly ground would have been excessive. One method considered consisted of building concrete walls between sheet piling, dredging the material and building a concrete floor under water. Afterward the water was to be pumped out. As the hydrostatic pressure would have required a floor 3 ft. thick another way of construction was looked for.

SITE OF RESERVOIR

Close by the site runs a river, whose surface lies about 4.3 ft. above the ground water. This difference in elevation led to the adoption of a rather novel method. Between the future site of the basin and the river the ground was excavated down to the ground water surface. On this flat the concrete work for the basin was constructed. At the same time the site for the finished structure was dredged to the required depth. After the concrete had set water was let in from the river and the basin floated in place and sunk. This sinking was not, as originally planned, done by loading the basin, but by pumping out the water by electrically driven pumps.

In designing the basin, which is 165 x 50 ft. in plan, care had to be taken not to make it too heavy. The total draft available was 4.3 ft. and as a great force would be needed to overcome the adhesion on the bottom it was decided not to let the displacement exceed 3.3 ft. Its walls and bottom, therefore, were made of thin reinforced-concrete slabs supported on beams which in turn were connected with six transverse reinforced-concrete trusses. After the basin had been sunk the floor was thickened by additional concrete.

The design and construction was carried out in accordance with specifications drawn by the Public Service Commission of Strassburg, Germany, by the firm of Ed. Züblin & Cie. The undertaking has been described in the August issue of "Armierter Beton."

VIEW OF COMPLETED SIX-STORY WAREHOUSE AT ROCHESTER

New Six-Story Railroad Transfer and Storage Warehouse at Rochester

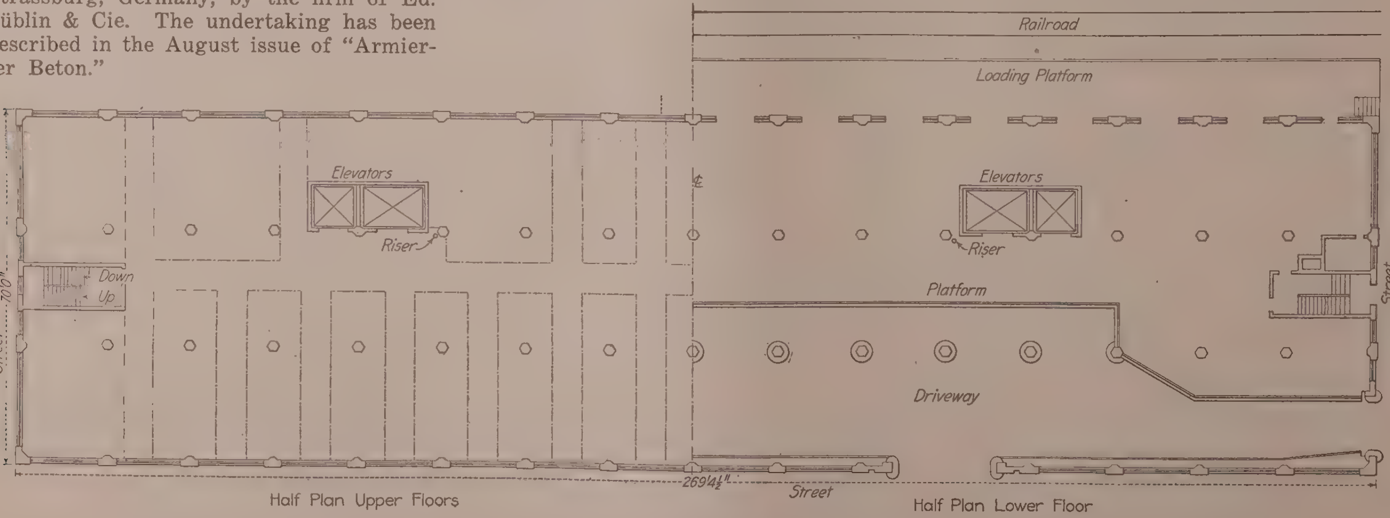
Building of Buffalo, Rochester & Pittsburgh Railway Specially Designed to Economize the Handling of City Merchandise

EFFORTS on the part of the Buffalo, Rochester & Pittsburgh Railway to facilitate the transfer and delivery of merchandise in cities and to increase the convenience and economy of storage have resulted in the design and construction of a 269 x 70-ft. reinforced-concrete six-story railroad freight warehouse in Rochester, N. Y. The idea is a result of a study by W. C. Noonan, president of the company, of the problem of handling carload and less-than-carload lots of merchandise, largely for city stores, where the entire consignments cannot always be immediately received and where portions of them are frequently classified, separated and held, distributed or reshipped.

In accordance with his ideas the building now under construction, was designed with special provisions for receiving merchandise from freight cars in such a manner that it can be advantageously stored, transferred or delivered in whole or in part by trucks as unloaded. The present building is one of a proposed group of three units arranged on both sides of the railroad track and provided with an interior driveway on the side of the building opposite the railroad track, so that the shipments, receipts and deliveries can be made on ground level and goods stored in the upper stories without confusion, interruption or unnecessary rehandling, and at a minimum cost.

ARRANGEMENT

In the first story there is at car-floor height a full-length exterior platform 12 ft. wide, from which cars are loaded or unloaded. This communicates with the first story through a wide door in each of the sixteen panels between wall columns, and thus allows for handling merchandise directly across from the cars to trucks waiting in the building on the opposite side, or to elevators taking it to the upper floors for storing. About a third of the ground floor, on the side adjacent to the street, is devoted to trucking space, which occupies nearly all of the area between the wall and the first longitudinal row of columns, and provides a full-length driveway from end to end of the building, as well as an enlargement about 170 ft. long and 11 ft. wide beyond the intermediate columns. The driveway extends up to the trucking platform and permits trucks to be stationed, one in each panel between columns, without interfering with the movement of trucks in the driveway. Wide side doors permit intermediate entrance and exit to the driveway, so that the movement through it may be continuous in one direction. This arrangement se-



UPPER AND LOWER FLOOR HALF PLANS, SHOWING INTERIOR DRIVEWAY, ELEVATORS AND SCHEME FOR TIERING cures the automatic placing and locating of trucks and provides ample space for them without waste or interference.

There are two groups of elevators located eccentrically from the longitudinal axis of the building, and about midway of the space between the truck platform and the railroad platform, to both of which they have entrances. This location removes them far enough from the gangways in the upper stories to give unobstructed clearance in the latter, regardless of trucks entering and leaving the elevators.

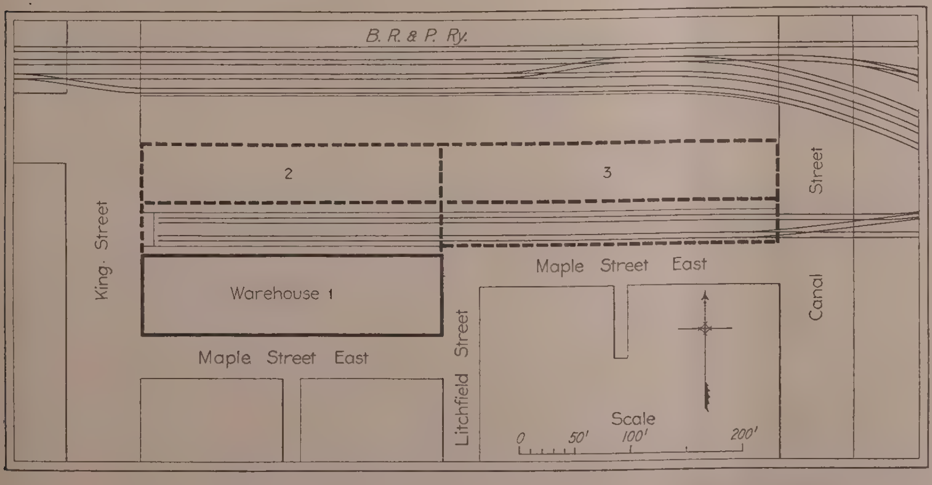
On the center line of the building at each end is a fireproof stairway well transverse to the end wall instead of parallel to it as is generally the case, thus providing entrance to it from the center longitudinal aisle and leaving all the space on both sides available for storage without the necessity of providing a passageway there to the stairway.

It is intended that the storage space on the upper floors shall be occupied as shown by the light lines in the floor plan, which indicate stacks of merchandise extending from the side wall to the center aisle on both sides of each transverse row of columns, thus leaving between them a single longitudinal passageway giving access to transverse passages in both directions in every panel of the building. The floors are proportioned for loads of 350 lb. per square foot on the first floor, 300 lb. on the second and third floors and 250 lb. on the fourth, fifth and sixth floors.

CONSTRUCTION AND EQUIPMENT

The building is constructed entirely of reinforced-concrete proportioned in accordance with the local building laws for compression stress on concrete—650 lb. per square inch in the spirally reinforced columns. The reinforcement of the floor slabs consists of wire mesh, which was used to avoid the danger of displacement of small rods. The windows are all placed near the ceiling to permit goods to be piled against the exterior walls without danger of breaking them. The building is equipped with fire doors, steel window frames and sashes, fire sprinklers and intercommunicating telephones, and is designed especially for strength, safety and durability. Considerable attention has also been given to architectural considerations, and the exterior has been treated to give it a pleasing effect. To avoid the unsightly appearance of the 50,000-gal. sprinkler roof tank, this is inclosed in a central tower flanked on either side by lower towers containing the elevator machinery, which is installed entirely above the roof.

The building will contain about 5000 yd. of concrete and 620 tons of steel reinforcement and will cost about $200,000. It is expected that the building will be ready for service in December, 1914. It was designed by Maynicke & Franke, of New York City. Gorsline & Swann, Rochester, are the general contractors.



RELATION OF WAREHOUSE 1, BUILT FIRST, TO ULTIMATE DEVELOPMENT

Convention of Port Authorities

Abstracts of Two Papers Presented at Third Annual Meeting of National Association at Baltimore, September 8, 9 and 10

Federal and Local Duties in Port Development

By COL. WILLIAM M. BLACK

Corps of Engineers, U. S. A., New York City

FROM the beginning of this Nation the powers of the United States over the instruments of interstate commerce have been supreme. The local laws of the various States relating to the navigable waters originally differed in accordance with the origin from which sprung the first settlers. In all, the control of the navigable waters had been vested in the Crown as a trust for all of the people. In the transfer of sovereignty this right of control had become a part of the powers of the people—at first of the separate colonies, but later surrendered by the States, their successors, to the Nation. When new States were formed from the acquired territory the provisions of the Constitution were made applicable to them. Thus the rights of navigation had been made common to all of the people and the laws enacted for the preservation of these rights are National laws enacted by Congress. The several States may and do enact legislation regarding the navigable waters within their limits and such are valid insofar as they do not conflict with the laws of the Nation.

In the administration of the laws relating to navigable waters the question of the ownership of the submerged lands does not enter. The rights of navigation extend to the high-water mark of tidal waters and to the ordinary water line on non-tidal waters, irrespective of such ownership, and the use which an owner of lands submerged by the navigable waters can make of his property must be such as does not interfere with the prior rights of navigation. All constructions in or changes of capacity of navigable waterways are forbidden unless specifically authorized by Congress, or in certain cases by the Secretary of War, to whom Congress has deputed a limited discretionary authority.

SIGNIFICANCE OF HARBOR LINES

The establishment of harbor lines grants no privileges of ownership, but simply signifies that within the limits set by the lines there is no objection made by the United States, as trustee for the people, to the use of these submerged lands for the class of structures authorized. The establishment of harbor lines is in the nature of the issuance of a general permit. Within the areas bounded by the harbor lines the uses of the submerged soil may be still further regulated by State authority.

The powers of the United States in the control and improvements of its navigable waters is paramount over all individual or corporate rights as riparian owner. So, also, works for the benefit of navigation may be constructed on lands submerged by the navigable waters, and access to upland shore property may be denied by such works without the owner having any right of compensation against the United States.

The foregoing shows the nature and scope of the laws of the United States for the protection of the people's rights of navigation. Under these laws the Nation improves and maintains the waterways which have to be free and open for the use of all.

Just here arises the distinction between the functions of the National officials and those of the State or municipal officials charged with port duties. Those of the former relate to the general needs of commerce. Those of the latter to the special transfer needs of the particular port. Both are of the highest importance and there should be no clashing of interests. In its ultimate results any impairment of National interests must be detrimental to the local interests.

REQUIREMENTS OF A PORT

In addition to deep, safe and unobstructed channels of entrance and of communication, provided with ample and safe anchorages, the general requirements of a great commercial harbor are:

1. Accommodation for express passengers and package freight traffic. These should be of ample capacity, located conveniently to railroad terminals and to hotel and shopping centers, and connected therewith by highways unobstructed by railroad grade crossings and provided with facilities for rapid transit.

2. Piers for the direct interchange of traffic between water and railway carriers. These must also be of ample capacity and must adjoin large yard areas, free from vehicular traffic. They should not be located in the heart of a city's waterfront.

3. Piers for freighters whose cargoes are distributed or received from many different sources. These should have ample means of access for motor and horse trucks with

yard space for temporary storage of such vehicles. Also, they should be interconnected by a railway with connections to trunk lines and possibly to bonded warehouses. The slips should be wide enough to permit of lighter service with other parts of the harbor.

4. Accommodations for pleasure craft.

5. Ample waterfront for large manufacturing plants, which use water and rail carriers for raw materials and finished products. Such plants requiring large areas for proper development should not be located near the heart of a port.

6. Municipal piers equipped with unloading plant or with coal-handling plants for use of manufacturers whose works are located back from a waterfront.

It is evident that in a port which has grown simply by individual development and not according to a well-thought-out plan a wise distribution of the various classes of traffic is impossible and an uneconomical arrangement must exist with resulting financial loss. Yet, it is only of recent years that effective steps have been taken toward systematic port organization and development on this side of the Atlantic. Municipal or State ownership and control of waterfronts is essential to this end, and municipal or State authorities must control.

Establishment of Harbor Lines

The establishment of the location of the harbor lines has frequently formed a bone of contention between the National authorities and the local interests. It is but natural that riparian owners should seek to increase the area and commercial facilities of their property by encroachments on the waterway. At times this can be permitted without detriment to the general interests; at others it must be forbidden. Since the real interests of both the Nation and the locality are, in the broadest sense, the same, both the local and the National authorities should be able to work in harmony in the establishment or rearrangement of harbor lines. Experience has shown that where there is no carefully considered local control of a port the establishment of harbor lines may be really detrimental. Cases can be cited where a short-sighted riparian owner has created solid fill just as far channelward as was permitted and has covered that fill with his structures, but has later found that he had left himself insufficient pier area, with a result of curtailment of the business capacity of his property. This has been followed then by importunate requests for the further movement channelward of the pierhead line.

Co-operation

The remedy for this can be obtained by co-operation between the National and local authorities of the port. It is not always possible to foresee what areas of a port's short line will be needed for manufacturing plants requiring limited pier lengths, and what areas will be required mainly for pier and slip purposes. Under these conditions, it is possible that one of two courses may be advisable. One of these is to establish simply a pierhead line, which should be the limit of any construction of any kind channelward and then, as each property is to be developed, have the plans for that development passed upon by the local authorities and construction authorized under a permit from the National authority. Under such a policy the onus for an unwise extension of upland at the expense of restricted shipping facilities may always be fixed on the riparian owners. In this connection it may be noted that experience in New York has shown that practically all of the circulation of water in the stream is between the opposed pierhead lines and that the effect of the space between each pierhead line and its corresponding bulkhead line is negligible insofar as the movement of the waters and the effect of such movement on the river bed and banks is to be considered. Where this is the case open and solid-fill piers have identical effects on the regimen of the waterway.

Another course would be not to establish formally any harbor lines but to lay down a theoretical pierhead line for the guidance of responsible officials which should serve as a limit channelward for all structures for all shore developments, and to have the right to make those developments up to that line, after having been properly and duly considered and recommended by local authorities, granted by a Federal permit for each individual case.

In the operations of port protection and development, like any great public work, some interests are bound to suffer. Port officials, both Federal and local, must form judgment of the propriety of each project presented from the standpoint of the broad general interests of the Nation and of the locality and must be prepared to face pressure and criticism from those whose existing or prospective wants have to be sacrificed.

State Control over Ports and Waterfronts

By B. F. CRESSON, JR.

Chief Engineer, New Jersey Harbor Commission

PRIVATE ownership and control in many of the larger European ports has given way to public ownership and control, and in some cases public operation of port facilities has been successfully conducted. There is no question about the success of the ports of Montreal, New Orleans and San Francisco, which are not only under a large degree of public control and ownership, but also under a considerable degree of public operation. At the ports of Boston, New York, Philadelphia and Baltimore on the Atlantic Coast and at Los Angeles, Seattle and Portland on the Pacific Coast, as well as certain other ports, public control and public ownership have, to some extent, been practised, but public operation of port facilities has not been attempted to any extent.

It has been the policy of transportation companies to acquire the most advantageous waterfront location in order that they may provide themselves with the best terminal arrangements: and it has often been the case that, looking toward future expansion and possible competition, such companies have acquired and are holding waterfront property in excess of their needs.

Control Over Private Development

Public control over the waterfront, to be effective, should include the power to pass on plans for private development. This should include the right to forbid such work to be done as is deemed improper. It should guard the public interest and not permit private work to be done which will tend to create disastrous monopolies, or which is likely to injure unduly adjacent properties, or which will not fit into a general scheme having in view possible future public ownership and possible future public operation.

Public ownership is useful and under some circumstances necessary in order to encourage the private operation of utilities created at public expense. It can build port facilities in advance of necessities and thus encourage commerce. It can build port facilities which may themselves be unprofitable, but whose operation may be useful and necessary for the welfare of the hinterland.

A Government, State or municipality can, as a rule, borrow money at a less rate of interest than can a private individual or corporation, and does not necessarily have to realize a profit on its investments, but only to meet the interest charges and to provide a sinking fund. Public investments for terminal facilities can, in many cases, be leased to private individuals or corporations on terms which will render the public investment self-sustaining, and which, at the same time, will be advantageous to the private individual or corporation by reason of the lower rate of interest on public bonds.

Useful Private Utilities

Public ownership should not destroy or injure useful and proper private utilities. As above stated, the public borrows at a less rate of interest, in addition to which the public is relieved from the necessity of paying taxes and does not have to seek profit on its investments. Hence it is manifestly unfair for the public to enter into competition with useful private utilities.

Public operation of port facilities has been successfully undertaken—particularly in European countries. Political conditions in this country add greatly to the difficulties of public operation. The general experience in this country is that public operation in direct comparison with private operation has been unfavorable to the former. There have been instances of the abuse of private operation where public operation for the benefit of the community has become necessary. There have been instances where private operation has become unprofitable as such, but where the public welfare requires that operation be maintained, and it has been a choice between a public operation at loss or private operation encouraged by a public subsidy.

Settling Basins at the St. Louis water purification plant have been cleaned seven times during the year ending April 1, 1914; 149,881 cu. yd. of deposit have been removed from four basins at a total cost of $2,135.36 and a unit of $0.0142 per cu. yd., acording to the annual report of Edward E. Wall, water commissioner. The costs given are for labor, teams, furnishing and keeping in repair all tools, boots, etc., used in cleaning, and of moving apparatus to and from the basin before and after cleaning. The water lost in drawing the basins preparatory to cleaning was approximately 200,000,000 gal., and that used during cleaning 130,000,000 gal. In addition the mud gates have been opened a total of 360 hr. during the year for the purpose of flushing out loose mud, thus enabling the basin to be kept in service a longer time than would otherwise be possible. About 360,000,000 gal. have been used in this way.

Twin Peaks Rapid Transit Tunnel in San Francisco

Double-Track Electric Railway Tube, 12,000 Feet Long, Will Bring 7000 Acres of Inaccessible Land Within 10 Minutes Ride of City Center

THE second attempt to place under contract the construction of the 12,000-ft. double-track Twin Peaks electric railway tunnel in San Francisco, estimated to cost $3,500,000, will be made Sept. 30, when bids will be opened. At the first call for tenders on Aug. 19 none was received, due, it is believed, to difficulty on the part of contractors in meeting the city's requirements as to the amount of bonds. In the readvertisement of the work the bond for faithful performance is $500,000 and for workmen's compensation insurance, $200,000. Six hundred calendar days are allowed for the completion of the contract.

The tunnel will develop into home sites 7000 acres of hitherto inaccessible land—approximately one-fourth of the land area of the city. With high speed trains the time of transit through the tunnel will be 10 min., as compared with 30 min. by existing routes. The plans and specifications were prepared under the direction of M. M. O'Shaughnessy, city engineer, from whom the following data have been received:

The alignment of the tunnel gave rise to two factions, one advocating an alignment along a straight line between the two portals and the other advocating a location following under easy surface grades to the intersection of Eighteenth and Hattie Streets, and thence in a straight line to the westerly portal. The latter location was adopted, and a strip of land 1956 ft. long, averaging 90 ft. in width through the property traversed, will be acquired in fee simple, thus at one stroke providing a tunnel right of way and a surface strip of land for a contour extension of Market Street by easy grades impossible under the first scheme.

Commencing at the easterly portal near the Eureka transfer station, the tunnel will ascend on a 3-per cent grade for a distance of 9,000 ft., an allowance being made for the additional friction of trains on curves by reducing the gradient to 2.87 per cent on such portions. At the termination of this 3-per cent grade will be constructed a second station to be known as Laguna Honda station at an elevation of 436 ft., the floor of the tunnel being 62 ft. below. From this point the grade will descend at the rate of 1.15 per cent for a distance of 3,000 ft. to the westerly portal.

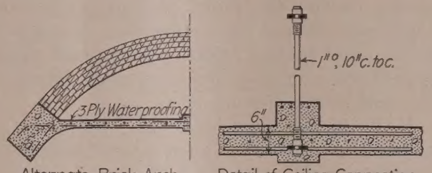
RATES OF GRADE

The consideration of two important factors operated to fix the rate of grade from the easterly portal to the Laguna Honda station; first, the desirability of a station at the location adopted for Laguna Honda, and, secondly, the necessity of operating the trains at high speed. The second fixed the maximum gradient at 3 per cent, while the first required the use of this maximum in order that the tunnel might be brought within a reasonable distance of the surface at the point selected for the station.

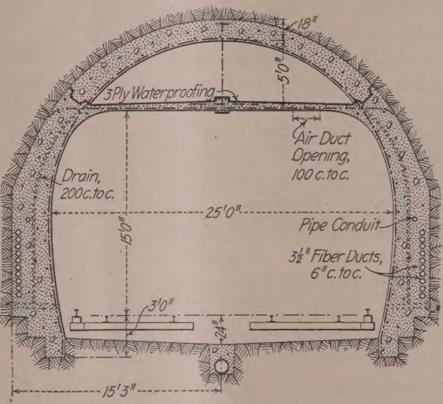
Borings along the route at intervals of from 300 to 400 ft. indicate that for a distance of 5,000 ft. on the westerly end sand and incipient sandstone will be encountered, passing thence into hard Franciscan sandstone for a distance of 4,500 ft., and emerging into a red sandy clay for the remaining 2,500 ft. to the easterly portal.

The inside dimensions adapted for the tunnel proper are 25 ft. in width and 15 ft. in height, and, as the borings indicate the presence of considerable water, the curve of arch was made semicircular and the sides slightly curved. The construction of an inverted arch in the bottom is provided for, in case it is found necessary in order to resist the hydrostatic pressure. Where street grades reduce the clearance a flat top subway section is provided.

Throughout the entire tunnel a 12-per cent mixture of hydrated lime will be added to the concrete, which, together with a rich mixture of cement and sand applied with a cement gun, it is believed, will afford sufficient waterproofing for the tunnel and subway sections. About Eureka Valley station, where leaks and water stains would be offensive, three-ply felt waterproofing is to be laid on the top and sides of the structure and covered with porous tile, through which water will percolate and be drained off through the interior holes to weep holes at the base of the station.



Alternate Brick Arch Detail of Ceiling Connection



SOFT ROCK SECTION, TWIN PEAKS TUNNEL
(Showing Ventilating Air Duct Near Crown of Arch)

The important matter of ventilation has been given much attention, and the plans call for the construction of a circular vent shaft capped by a head-house or air intake of attractive design on the surface. In this shaft electrically driven blowers will be installed. These blowers will draw fresh air from the atmosphere and force it through an air duct formed between the upper portion of the tunnel arch and a suspended reinforced concrete slab ceiling from which it is allowed to escape at intervals through dampers into the tunnel proper, and thence to the surface at the portals and stations. In each wall of the tunnel lining will be placed eleven fiber ducts for the accommodation of cables and wires transmitting the electric current for the operation of the trains and for lighting the tunnel and stations. The plans do not call for the installation of track.

FINANCIAL ASPECTS

The estimated cost of the construction of the tunnel, including the purchase of lands for rights of way and other incidental expenses, is $3,994,000. Of this amount $3,399,000 will be contributed by that portion of the assessment district lying west of Twin Peaks, containing an area of 4,153 acres, and $595,000 will be contributed by that portion east of Twin Peaks, containing an area of 660 acres. The average assessment is on the basis of 2 cents per square foot ($50 for a lot 25 x 100 ft.). The maximum is 3½ cents per square foot and the minimum 0.5 cent per square foot. The assessment will be payable at the option of property owners, either all at one time or in ten annual installments, or property owners may pay one-tenth when the assessment becomes due, or as much more as they elect, and they may either pay the balance in ten annual installments or they can pay the full amount prior to maturity.

Demolition of a Long-Span Cast-Iron Arch

Removal of Old Southwark Bridge in London without Interrupting Highway Traffic or Navigation

THE Old Southwark Bridge over the Thames River in London was a highway structure 42½ ft. wide with two 210-ft. and one 240-ft. span. Each span had eight cast-iron flat arch ribs carrying cast-iron latticed longitudinal spandrel girders and a cast-iron plate floor. Each rib was divided into thirteen voussoirs about 3 in. thick and from 6 to 8 in. deep. At every joint these were separated by transverse radial diaphragms to which they were connected by dovetail wedges. The bridge had been in service ninety-five years and was considered an unsurpassed example of this class of design.

The removal of the old structure to make way for a wider new bridge on the same site was described in "Engineering." In the removal of the old work and the construction of the new it was necessary to provide for the maintenance of pedestrian traffic and for the navigation of about a thousand craft of all descriptions passing under the bridge every twenty-four hours. This was accomplished by the construction of falsework spans on both sides of the old bridge and the installation of footwalks on them.

FALSEWORK SPANS

These bridges were each made up of five spans from 85 to 194 ft. long and each structure had two continuous lines of steel riveted lattice girders 16 ft. deep, 10 ft. apart on centers and 712 ft. long, supported on piers made of 12 x 12 and 14 x 14 in. wooden piles. The two falsework bridges were 74 ft. apart on centers and their inner trusses were connected by transverse plate girders 4 ft. deep and 19 ft. 4 in. apart, clearing the top of the old cast-iron arch bridge. The ends of these girders were connected by longitudinal struts and the panels between them were X-braced with angles in the planes of the top flanges throughout, the long center span having an additional lateral system in the plane of the bottom flanges.

Additional support for all of the arch ribs was afforded by wedging them up on falsework trestles at the springing lines and at the centers of the side spans. No falsework was permitted to obstruct the river under the long center span. The arch ribs were braced by wire-rope ties to the footbridges and had a system of diagonal ties reaching to the steel falsework tower on top of one of the center piers.

Movable longitudinal jigger beams made

of pairs of channels back to back were seated on the top flanges of the transverse girders in the planes of the arch ribs. The voussoirs were temporarily supported from the jigger beams by riveted yokes made of vertical angles and horizontal bearing and saddle plates connected to the jigger beams by adjustable vertical bars. This arrangement supported the ribs after the arch action was destroyed and allowed the successive voussoirs to be removed without difficulty. The voussoirs and other material were handled by three overhead traveling electric girder cranes with their trolley hoists moving between the main lattice girders.

The transverse frames, the long wedge keys and some of the voussoirs were broken up in position by means of rows of holes drilled through them by electric machines, after which drifts were driven in until the castings broke through the line of holes. The crown segments were cut in this way and afterward lowered until they cleared and were removed by the girder cranes. As the center span could not be obstructed by barges to receive the voussoirs, they were cut in pieces, hoisted through the floor and transferred to the side spans.

Book Reviews

The International Joint Commission appointed to study and report on the pollution of the boundary waters between the United States and Canada has published a progress report. It contains about 400 pages and is illustrated with numerous maps. The report deals principally with the results of the extensive bacteriologic examinations of the Great Lakes and their tributaries. The data involve maps showing the location of the various sampling points, the detailed tabulation for each sampling point, the average bacterial count per cubic centimeter, number of samples collected, dates of collection and illustrations showing graphically the source, degree and extent of the pollution as indicated by the bacterial findings. The report indicates a vast amount of work on the part of the Commission's sanitary experts, Allan J. McLaughlin, John W. S. McCullough, John A. Amyot and Frederick A. Dallyn. (The International Joint Commission, Washington, D. C.)

HANDBOOK OF TABLES AND FORMULAS FOR ENGINEERS. Compiled by Clarence A. Pierce, Instructor in Power Engineering in Sibley College, Cornell University, With Mathematical Sections by Walter B. Carver, Assistant Professor of Mathematics, Cornell University. Leather, 4 x 7 in.; 168 pages. New York, McGraw-Hill Book Company, Inc. $1.50 net.

This handbook, while compiled particularly to meet the needs of students of the Sibley College of Mechanical Engineering at Cornell University, should prove useful to all civil engineers.

The authors have divided the book into ten sections, of which the first four are purely mathematical. Algebra is disposed of in two pages, in which the solution of equations, the binomial theorem, the square of a polynomial, progression and logarithms are discussed briefly. Geometry and trigonometry are treated together in nine pages, considerable attention being given to solid figures. Fourteen pages deal with analytic geometry, seven of them being given to equations and plots of twenty-six of the less common curves. Forty-one pages, mostly differential and integral formulas, dispose of calculus. Presentation of the principles of maxima and minima is conspicuous by its absence.

Section 5, on measurements, presents in ten pages all the direct and conversion tables one is likely to need, including weights and measures, electrical units and mechanical and heat-energy equivalents. Ten pages of physical and chemical properties of substances follow.

Section 7 contains twenty-six pages on mechanics, including twelve pages of tabulated properties of beams and sections, and is followed by three pages on strength of materials. Section 9, containing eighteen pages, is devoted to standard gages, fastenings and flanges. The last section, fifty-one pages, contains the familiar mathematical tables. As the logarithms and natural functions are to four places only, they will hardly replace the more accurate ones most engineers have. An interesting feature is a two-page table of fifth powers and roots, and there is also a B.t.u.-entropy chart of thermal properties of steam.

It is to be regretted that there is no hydraulics section, as such a work seems incomplete without at least the more common formulas for flow of water. As the book was compiled primarily for students, it seems as if more space could well have been given to algebra, and even arithmetic, dealing with the use of factors and other shorthand methods that make for quick and accurate computations. Such hints would not, in fact, be amiss for many older engineers. In general, however, the book is well prepared and should prove very valuable.

POWER AND POWER TRANSMISSION. By E. W. Kerr, Professor of Mechanical Engineering, Louisiana State University. Cloth, 6 x 9 in.; 391 pages, 325 illustrations. New York, John Wiley & Sons, Inc. $2.00 net.

Although the author states in the preface that this edition has been partially rewritten and brought entirely up to date, the reviewer cannot see that it is much more up to date than the last edition. There are many grave errors in presentation of the subjects and one can hardly conceive that an engineer had anything to do with its compilation. The first part of the book is an extremely elementary treatment of some points in mechanics while the latter part of the book very briefly mentions the different kinds of prime movers and methods of transmitting power and motion. There is hardly anything but what could be found in the makers' catalogs from which both cuts and material have the appearance of being taken. This book should have no space in any technical library.

MODERN TUNNELING. With Special Reference to Mine and Water Supply Tunnels. By David W. Brunton and John A. Davis. Cloth, 6 x 9 in.; 450 pages; 80 illustrations. New York. John Wiley & Sons. $3.50 net.

This book, written by men who for years have been connected intimately with tunnel and mining work, and who have been fortunate enough to be given unusual facilities to visit tunnels under construction in various parts of this country, will undoubtedly be heartily welcomed by tunnel engineers and contractors, mine owners and superintendents.

"Modern Tunneling" is adapted especially to those who wish to obtain a maximum amount of practical information at a minimum cost of time, and to this end the summary of several chapters will be found of valuable assistance to readers. In chapter 2 an interesting review is made of the history of ancient and modern tunneling methods, including tunnels driven by hand and by machine drills. Railway tunnels of various countries, including Japan, are mentioned briefly also. In chapter 3 a description of tunnels and adits visited by the authors is given. A broad field has been covered, and much useful information is given in brief but concise form. Chapter 4 bears on the source and production of power in connection with tunnel work. The advantages and disadvantages of steam and internal-combustion engines, together with electric motors driven by steam or water power, are ably presented and discussed, and a broad field is predicted by the authors for oil engines of the Diesel type. The cost of installing several plants and the fuel consumption and thermal efficiency of various engines are presented briefly, together with the cost of electric current. The chapter ends with conclusions bearing on the selection of the type of power plants most suitable under various conditions. In some 30 pages air compressors and their accessories are described, discussed and freely illustrated. Besides straight line and duplex compressors, turbo-compressors are mentioned, the advantages and disadvantages of each type being ably exposed and discussed.

The chapter on ventilation is rather brief. Methods used for ventilating mine and water-conveying tunnels are presented, together with a table giving the capacity of blowers, size of ventilating pipe, air pressure, etc. Under the title "Capacity" the authors complain of the lack of rule for determining the amount of air needed for ventilation in tunnels. Theoretically this is true. There are formulæ, however, which, when used with judgment, and when account is taken of the amount of carbon dioxide excreted by men, animals and lights and produced by the consumption of explosives, of the heat generated by men, animals and lights and that due to the surrounding rock, and of the gases liable to be encountered, give far more reliable results than ready-made tables or rules of thumb do, and especially more than the laws enacted by various States with reference to the amount of air to be supplied, per man, in connection with mining work.

Chapter 8, bearing on rock drills, is complete within its scope, and well illustrated. It would be more complete if more weight had been given to air hand drills, which are now being used extensively in heading and tunnel work. In the heading of the Hauenstein tunnel an average progress of 750 ft. per month was made during a whole year with an average of three such drills in operation, the heading having a cross-sectional area of about 78 sq. ft. The authors discuss very fairly the various types of drills found on the market. The uncontestable advantages of hammer drills for tunnel work are ably exposed, while the future of electric drills is pointed out in a more conservative manner, although much weight is laid on their low power consumption.

In chapter 9 tunnel cars, loading machines, motive power and dumping devices are described and well illustrated by drawings and half-tones, together with interesting tables bearing on mucking cars and the cost of gasoline haulage.

The contents of chapter 10 cannot be but commended. There is a broad field, both for inventors and investors in developing tunneling machines, but, as the authors point out justly, investors are cautioned against flamboyant literature, distributed only too freely by dishonest speculators. Under the title "Illumination" there is an interesting table showing the use and distribution of various lighting systems, and among items entering under underground equipment, the extensive use of telephones in tunnel work, as advocated by the authors cannot be too strongly recommended.

To drilling and blasting, twenty-seven and twenty-three pages are devoted respectively. Both subjects are treated very thoroughly, yet it is to be regretted that comparisons are established between methods used in driving small tunnels in this country, and headings of long and deep tunnels abroad, which, if driven under similar conditions of labor and wages, would undoubtedly be more costly. The cost of driving headings of long tunnels can be expressed only when taking into consideration the enlargement and lining work, and as a matter of fact the whole bore, the cost of which depends to a large extent on the manner used and speed attained in driving the heading.

Chapter 14 bears on the timbering of small tunnels. Sketches are used freely to illustrate methods used most frequently in connection with mine and adit work and water-conveying tunnels. Sixty-one pages are devoted to safety and precautions against accidents in conneetion with tunnel work, and it is the reviewer's most sincere hope that this chapter will be read twice by tunnel men, from mine owners and contractors down to tunnel or heading foremen.

The value of the book is greatly enhanced by chapter 16, bearing on the detail costs of tunneling, and by the most detailed and up-to-date bibliography on tunneling published in the English language.

In concluding, the reviewer cannot help pointing out that "Modern Tunneling" is very nearly a copy of Bulletin 57, prepared by the same authors, and published by the U. S. Bureau of Mines.

Letters to the Editor

Formulæ for Wind Stresses

SIR: Some of your readers may already have taken exceptions from the assumptions and consequent deductions by D. Gutman, in his article on "Formulæ for Wind Stresses" in the issue of Aug. 22, page 213, when general practice is under consideration. The columns are assumed to carry normal load without wind action and from that cause as well as from direct wind stresses and bending between floors due to wind will naturally have unequal areas and section moduli. It is by no means apparent why an untrue assumption should be made when the reality can easily be taken into account.

The true neutral axis can be determined as the center of gravity of the combined column area. The quota of direct column stress due to wind moment will be proportioned for each column to its area multiplied by the distance from this neutral axis. It is certainly also simple and justifiable to distribute the panel bending between floors on the different columns in proportion to their section moduli. Mr. Gutman's methods would seem to be all right for a first approximation in the unavoidable cut-and-try method necessary to assure sufficient strength without waste.

CHARLES R. STEINER.

Long Island City, N. Y.

[Mr. Steiner's letter has been submitted to Mr. Gutman, whose reply reads as follows.—EDITOR.]

SIR: Mr. Steiner and I can have no argument on the point he raises, as I consider it well taken. In the particular problem I had, conditions happened to be such as to make the total area of column necessary to take care of all stresses about the same for all columns. Mr. Wilson's analysis is unquestionably in frequent use. (See Mr. Fleming's letter in the issue of Sept. 5, page 284.) The point I wished to emphasize in my article was that if this method is used just as it is, without any further recomputation of stresses, as Mr. Steiner suggests, then the heaviest column will fix the section of the rest. The same applies to the girders.

DAVID GUTMAN.

Mount Vernon, N. Y.

Incentives that Help Men to Work

SIR: Mr. Fish's letter, in your journal of Sept. 5, page 283, and the editorial on page 261 of the same issue reminded me of an editorial in the Chicago Daily News of last March 16, in which the following is quoted from Nietzsche: "I do not seek my happiness; only an Englishman seeks his happiness; I seek my work."

Nietzsche undoubtedly had a grudge on when he made the remark quoted. A man of any other nationality might be substituted in place of the one he mentioned. "Work is nothing but a bitter burden to the primitive man," probably, but it behooves all civilized men to elevate work to the dignity that invites its most fervent courting and incites an envy for the privilege.

Some one said: "Art is to make the inert live." Give your work, whatever it is, soul, and it becomes alive and of interest and is art.

G. J. GRIESENAUER,

Cement Tester, Chicago, Milwaukee & St. Paul Railway, Chicago.

SIR: In your editorial of Sept. 5, "Craftsmanship Versus Money," you question the position which I took in the communication which you published in the same number. I was not greatly surprised at this, for my suggestion was one which is bound to seem radical to many people. Your position is one which I have taken many times, and one from which I have been driven only by years of contact with men of the two-dollars-a-day variety. I am most firmly convinced that my position is the correct one as things stand to-day, and I regret that I find it necessary to feel that way, but we are not going to gain anything by fooling ourselves.

You may educate men, but unless you succeed in doing something very different from what has been done in the past you will only educate from the top down. You will educate men to desire what they cannot attain. To use a slang phrase, you will give men a "champagne taste on a beer income," and that in itself is enough to account for all the unrest that there is to-day.

My boy sits next to a hod carrier's boy at school. They both come home with the idea in their minds that the kind of pictures that appeal to me as being good enough for our walls are not at all the thing. They can tell whether a picture is a real painting or whether it was oiled over to make it smell that way, but if I cannot afford to put on my wall the pictures that the teacher tells her pupils they should have, how far short is the hod carrier going to come?

How many hundreds of dollars it has cost me to keep the respect of my children because of what they have learned in school! Why, for five years I had charge of a trade school, and for three of them my daughter, now only fifteen, resorted to every subterfuge not to be seen on the street with me, because it was not "the thing." You may reply that this is not the kind of education that you mean, but it is the kind you get, and will continue to get so long as you place your public schools, your continuation schools and your corporation schools in the hands of school men. And they do it in the utmost good faith. Their point of view is all that is wrong. A man, to qualify for a teacher's job in a trade, continuation or corporation school, should produce evidence that he had earned his living by hard labor within his very active memory.

Now for a word from the workman's standpoint. A dollar is a mighty important thing. It spells first of all something in one's stomach, then it means a roof and warmth in the winter, and then it means clothes. Now, the run of men that get two dollars a day or less are too primitive to comprehend the relations of capital and labor. They can comprehend food, shelter and clothing, and they know by experience that lacking these alcohol will give them temporary relief. It is lamentable, but it is also true, that education must start from that point, and that gives education a long, hard pull.

Take almost any one of these men and give him wealth, and he would be injured by it; as likely as not he would see only a chance to get more alcohol. Take almost any one of these men and give him a little more than he has found to be the essential minimum to keep body and soul together and he will probably use it to deck out his spouse—or she will take it for that purpose —but there comes a time when, if let alone, he will gradually begin to rise to his position, not through education, such as we call by that name, but by example. His environment determines his standing and his income makes his environment.

I am not advocating any such wholesale increases in income as has been seen in the Ford shops—that is something to be regretted rather than emulated—but knowing as I do that a dollar is such a vital thing to men, I am certain that the shop that pays a little more, and a pitiful little at that, can select the cream of the men, and that that cream under the spur of its own necessities can be brought up to a higher point of efficiency than by any educational scheme that can be imagined. Ten cents a day is the deciding factor in many a man's employment. Ten cents a day in many a family determines whether they shall be the victims of loan sharks or whether they shall save money. A man who gets ten cents a day more than anyone else will give him will put forth every effort to hold his job; he will earn it over and over again, to the much greater profit to his employer than to himself, but to his own great satisfaction. If the man does not see it that way—and there are some too dull to grasp it—the ten cents a day gives the employer the pick of the men available, which is worth that, and many times that, to him.

Where does education come in? To my mind it comes only after the man is assured a full belly, a tight roof and reasonable clothes. Once safely away from the bread line you have something like a real man to deal with. Then you can begin to show him some of your troubles and he may believe you, but when a man is drowning don't start him taking even a correspondence course in business management. It doesn't pay. He will be dead before he grasps it.

E. H. FISH.

Worcester, Mass.

Factors Affecting Structural Timber

SIR: The fact that the strength of timber is proportional to its density, which is brought out in the article in the Engineering Record of Aug. 29, page 255, by H. S. Betts, administrative assistant of the U. S. Forest Products Laboratory, is deserving of especial emphasis from its importance as a characteristic upon which to base lumber grading rules. The numerous timber tests made under Mr. Betts' direction peculiarly fit him to speak with authority on this subject. He states that "It should be remembered that density is the basic factor governing the strength and that the proportion of summerwood as a satisfactory indicator of strength is dependent on the difference in density of the two parts of the annual ring and on the closeness with which these parts can be differentiated."

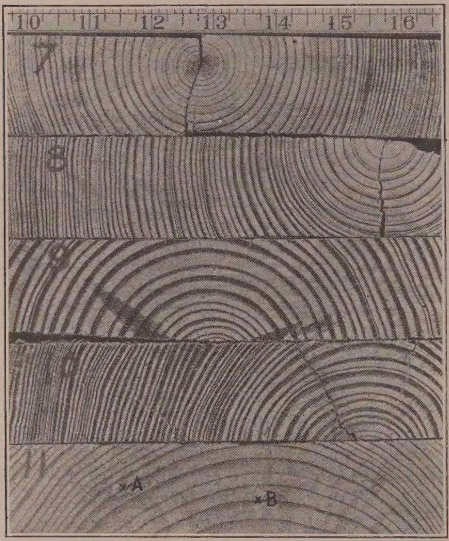


FIG. 1—PLANK PURCHASED AS LONGLEAF YELLOW PINE

Densities in pounds per cubic foot, dry, as follows: No. 7, 26; No. 8, 35; No. 9, 40; No. 10, 47; No. 11, 34 at A.

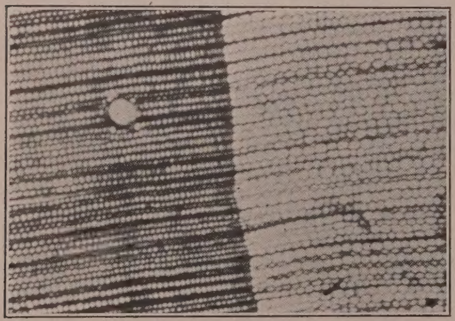


FIG. 2—PHOTOMICROGRAPH AT B, SPECIMEN 11 (SEE FIG. 1)

Showing gradual increase in amount of wood as summer advances. Magnification, 25 diameters.

In other words, the strength of timber is proportional to the amount of wood that it contains. This is shown by the accompanying photomicrographs. The wood of the several varieties of trees is similar, if not identical, in chemical composition. The specific gravity of solid wood is about 1.6. Therefore, if a timber were to consist entirely of wood, without air spaces, it would weigh about 102 lb. per cubic foot. The difference between this and the actual dry weight found is chiefly due to the air spaces in the wood cells, although incrusting substances such as rosin have some influence. The photomicrographs, made from sections cut across the grain of the wood, Figs. 4 and 5 show that the ratio between wood and air space is much different in the springwood from that in the summerwood, and that there is also a decided variation in this ratio between different parts of the summerwood in the same or different specimens. In some specimens, as No. 11, Fig. 1, there is no well defined division between the spring and summerwood of the same year. Much of this specimen is of moderate density, as shown in Fig. 5; therefore the total density is considerably more than that of No. 7, in which most of the wood is similar to that shown in Fig. 6.

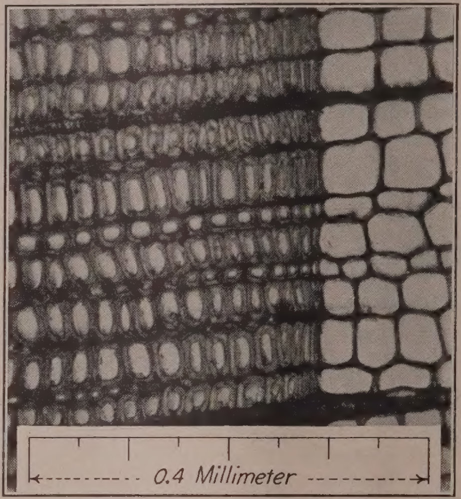


FIG. 3—PHOTOMICROGRAPH AT B, SPECIMEN 11 (SEE FIG. 1)

Showing more clearly varying proportion of wood to air spaces in summerwood. Magnification, 143 diameters.

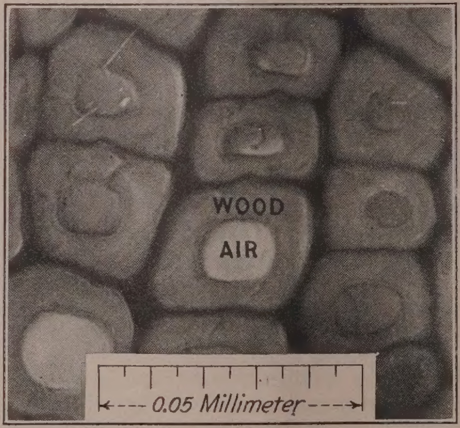


FIG. 4—VERY DENSE SUMMERWOOD

Magnification, 760 diameters

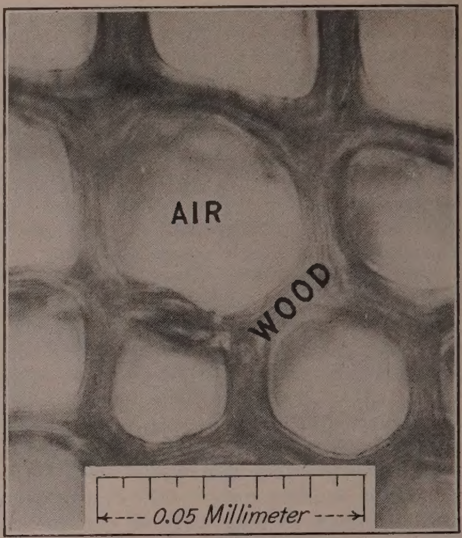


FIG. 5—MODERATELY DENSE SUMMERWOOD

Magnification, 760 diameters

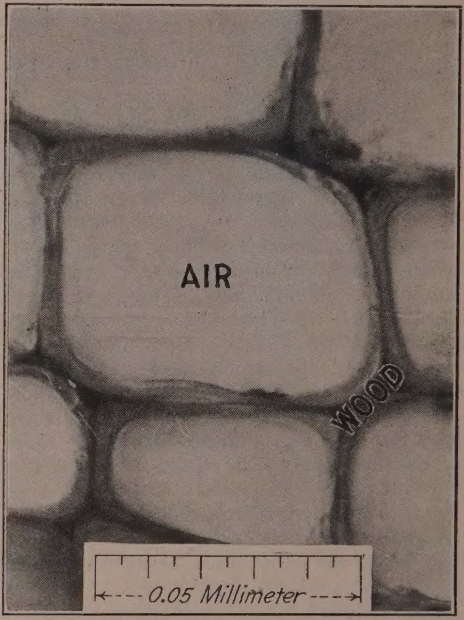


FIG. 6—LIGHT SPRINGWOOD

Magnification, 760 diameters

Therefore, while the proportion of summerwood is an approximate index of the density and of the strength of timber, its specific gravity is more reliable and can be determined with greater precision than the ratio of summer to springwood. It is for this reason better qualified for use as a final specification for structural timber, as it can be more conveniently used to avoid misunderstandings and to settle disputes.

F. J. HOXIE.

Engineer and Special Inspector, Associated Factory Mutual Fire Insurance Companies.
Boston.

CONFLICTING DOORWAY LAWS in Chicago are likely to lead to disasters similar to those which killed so many people at the time of the Iroquois fire. The South Park Commissioners insist that doors facing on Michigan Avenue shall not swing outward if they project even a few inches over the sidewalk. The city ordinance passed after the lesson of the Iroquois theatre requires all doors of factories, office buildings, hospitals, hotels, churches, lodge halls, theatres, department stores and schools to swing outward. Reasons given for the attitude of the Park Commission officials is that the doors swinging outward "might bump somebody."